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Conference topics:

A. Ideas of Water

B. The History of Water: Science and Technology

C. The History of Water: Law, Economics and Politics

D. Water Management in the Nile Basin

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Minutes from the IWHA Business Meeting 13.12.2003

IWHA Report 2001-2003

IWHA Work Plan 2003-2005

Theme A. Ideas of Water

121. Patricia Avila, Mexico

Water culture and environment in an indigenous region from Mexico

The indigenous population from the Meseta Purépecha -region allocated in the West-center of Mexico- has had to design during the centuries various strategies for improving the use and management of water. The reason is because in that region, water is a very scarce resource: there are not rivers, lakes or any other important sources, only small springs. Their strategies are based in: a) social and communal water control, that has guaranteed the free access to the population and the resource protection; b) the efficient use and management of water, that has permitted to profit in a way more rational; c) the diversified use and management of water, that has asked the utilization of all available sources, including rain water; and d) the multiple use and management of water, that has permitted to develop different productive and domestic activities and improve the water utilization through recycling and reusing.

Although the scarcity does not explain by itself neither the high value of water that the indigenous people (Purepechas) have, nor the logic that support the strategies of use and management. For that is important to deep in the socio-cultural dimension because water has sacred and divine values that are manifested in its myths, festivities and cultural practices.

In the Purepecha cosmogony, the human beings are part of nature and their relationship is based in principles of respect and harmony. This is because the mother deity is associated with nature (Cuerauahperi) and is connected also with the water deity (Ocupi Tiripeme). Thus, the human beings can not be in a superior level, only through a relationship of respect that is mediated by the technology and knowledge.

In this sense, the socio-cultural practices of water use and management are a projection of this cosmogony: water is a patrimonial good with high social value, that is protected to guarantee the present and future use. Also, the water use and management are based in ecological principles that permit an efficient, multiple and diversified utilization and the resource protection. For that reason, the relationship between water culture and environment explains the existence of an important magnitude of population since prehispanic times, in a region with a very limited water availability.

017. Kate A. Berry, USA

Scale as Contested Terrain in Water Conflicts

Scale is not often addressed with respect to conflicts over water use, yet competition over scale can influence the terrain of water conflicts and the history of policy decisions. Such competition includes tensions over the appropriate scale – regional, national, tribal, state/provincial or community -- to address issues as well as struggles about what to include (or exclude) at any given scale. Take as an example, the popular notion of community with its generally positive connotations. Using community as the basis for making water use decisions, however, is not without significance nor are community-based decisions universally superior to decisions made on the basis of other scales. And even if the scale of analysis seems obvious to all involved, conflicts over water often implicitly or explicitly involve struggles over the definition of that scale -- what is meant by community, for example, and what does this exclude. The point is that scale is socially constructed and, as such, is subject to competition within political and legal arenas used in resolving water conflicts.

The case study presented here concerns the McCarran Water Rights Amendment of 1952, which has had the effect of undermining Indian tribal sovereign immunity in water rights litigation. Throughout the development, passage, and judicial interpretation of this national water policy, ideologies about community (as well as about state, tribal and national scales) were projected into the policy processes. Western farmers and ranchers as well as government officials and Indian tribal representatives articulated different visions about how their positions attached to notions of community, state, tribe, and nation. This, I will argue, was more than simple rhetoric. Different visions of scale were consciously selected for Congress, the media, and the Supreme Court to underscore competing positions. This case study will provide insights into how scale can be contested terrain in water conflicts as ideas about

community are deployed and as tensions between national, state, tribal, and community interests are accentuated.

196. Bhattarai, Lok P., Nepal

Hierarchies of Water Control in Nepal Himalayas: A Reflection from Political and Cultural History of State Formation

Nepal Himalayas is one of the major geographic segments in the upper catchments of Indo-Gangetic plains. For that reason, it has been remaining mainly as a 'cultural watershed' of the civilization of the Indo-Gangetic plains of the south than the Tibet in the north. However, Nepal Himalayas has its distinct historical experiences than other parts of Himalayas in course of the evolution of cultural and political history. In this article, I depict how 'water', despite being a 'god-gift' product, deserves special cultural metaphoric meanings in the ecological history of this part of Himalayas. I will discuss the history of water use in light of the history of the evolution and diffusion of irrigation technology and the water management organization in course of the process of Nepali state formation.

This article focuses on depicting how, on the one hand, the Hindu notion of 'personhood', hierarchies of the roles of different actors in cosmic arrangement, worldview and, on the other, the politics of inclusion and exclusion, property right and the economic arrangement of production and distribution were nicely tailored in the logical framework of symbolic meaning of water. The article also illustrates how 'water' was taken as a marker of social boundary, which ensued as an arrangement of exclusion and inclusion of caste, ethnicity, sex and region in the larger structure of property regime. Secondly, this article discuss how the cultural arrangement for the hierarchies of water control has been ridiculously destroyed in the changed context of social transformation while state already went in the direction of secular democratic regime abolishing the olden arrangement. This article will also tend to precipitate the issue in the current context of social conflict and insurgency in Nepal Himalayas.

144. David Breen, Canada

Private versus Public Water Rights: The Foundation of Water Law in the Canadian Prairie West

The Canadian prairies comprise a vast region within the North American interior almost as large as France and Germany combined. Much of this region is semi arid and prone to extended cycles of drought. Currently in the midst of such a cycle, the renewed exodus of farmers and ranchers from the region underlines the precarious nature of agricultural endeavour in the region. Those struggling to remain, like their drought besieged forbearers, have appealed for massive government assistance. Both the nature of their appeal and the pattern of proposed assistance are framed by an extended public debate and body of legislation that was initiated in the midst of a similar just over a hundred years previous. This earlier debate centered upon the question of private versus public water rights. The seminal product of this debate was the decision to abandon the doctrine of riparian rights (an important article of Canada's inherited corpus of British common law) in favour of public ownership of all surface water in the Canadian Prairie west and northern territories. This remarkable decision introduced a new and progressive approach to water management unique to North American experience that was much admired by contemporary American observers such as Elwood Mead. It was a decision that had far reaching and lasting implications.

My proposed paper will examine this precedent setting debate concerning private versus public water, the economic and political environment in which it occurred as well as the particular and vital role played by one man - the visionary champion of public water, William Pearce. (A comprehensive evaluation of existing North American water law, as well as the laws and traditions governing irrigation practice in India, Egypt and Australia, led Pearce to conclude that effective and equitable water management had to be based on the principle that " water is the property of the public." Eventually able to persuade the Canadian Parliament to accept his notion that the government should hold title to all surface water in the prairie region, Pearce saw his principle of public ownership of water enshrined in the North West Irrigation Act of 1894) This paper will examine the intellectual and technical environment which informed Pearce's ideas and which were embodied in the North West Irrigation Act. In its abolishment of riparian rights, the Statute marked a fundamental turning point in law and since it remains the

foundation of contemporary water management in the region its impact was far reaching and lasting. This paper will reflect upon these implications, including the statute's impact upon aboriginal water rights.

106. P.G. Dhar Chakrabarti, India

Saga of a Lost River

The Saraswati was one of the mighty and highly venerated rivers of ancient India. It is widely spoken of in the Rig Veda as a life stream of people. The Mahabharata also speaks eloquently about the greatness of the river as a source of sustenance and inspiration of the sacred pilgrim centres on its banks. It also mentions that the river disappeared in the desert.

The mythical river is commonly believed to have flown through the north Indian city of Allahabad, meeting there with two other rivers, the Ganges and the Jamuna. The confluence or the Sangam of these three rivers - one of which is not visible - is considered one of the holiest spots of India.

But the mystery of this lost water course is set to be dispelled forever, as startling scientific evidence has come to light. Through satellite photography, scientists have mapped the course of an enormous river that once flowed through the north western region of India. The images show that it was 8 km wide in places and that it dried up 4,000 years ago.

Recent geological investigations at several places in northwestern India, in the States of Haryana, Rajasthan, Gujarat and up to the Rann of Kutch have enabled scientists to locate its palaeo-channels and dried-up beds. Archaeologists have located hundreds of settlements of ancient civilizations, which flourished on the banks of this mighty river. Due to climatic and consequent diversion, depletion of water, aridity and geotectonic changes, the Saraswati dwindled into an ephemeral stream and finally got lost in the Thar desert. Its decline and disappearance resulted in the decline of the civilization it supported.

The fine correlation of the geological and archaeological evidences with ancient literary references has opened up new vistas of research for a complete re-assessment of the antiquity of the Vedic and the Indus Valley civilizations. This paper will present the saga of this lost river as it has been recreated in recent researches across many disciplines.

169. Ngahaia Dixon, New Zealand

Cultural Significance of Water to Indigenous People in New Zealand, and the Effects of Non-Indigenous Water Usage and Management.

The Maori people of New Zealand are recognised as the indigenous people of the country. Our traditions and beliefs acknowledge a cultural link to many of the water bodies within New Zealand. These different water bodies, i.e. lakes, rivers, and coastal areas are under the guardianship of local tribal groups who live within the immediate locality.

Ways in which the rivers are used, protected and respected are a part of everyday life and are included in rituals at functions where and when kin groups gather. The water bodies are also an icon of tribal prestige and heritage, and are revered as a living cultural entity.

On the other hand formal authorities and other organizations local and national use the waterways for purposes which are deemed offensive and challenging to indigenous people. The use, protection and proper management of these water bodies has been a bone of contention for many tribal groups, where legislation has seen indigenous views ignored.

As indigenous people of New Zealand we are all too aware that water is a primary resource which is required for the community good. In our view this is a legitimate argument for water usage, but its use for biased gains, assisted by various pieces of legislation locally and nationally is anathema to the cultural thinking of Maori people.

This paper aims to present indigenous views of water, its use, protection and management through a window of cultural processes. It will contrast our views by presenting other non-indigenous water usage, management processes and other activities within New Zealand creating different views of the significance of water.

180A. Jean-Yves Durand, France

Hydrogeology and water-dowsing: countercurrents and confluences

The history of hydrogeology has been well documented by historians of science and technology. Folk conceptions on groundwater have been studied by anthropologists, who have also paid some attention to water-dowsing. However, these bodies of research generally lack an attempt at a joint analysis that would try to bridge the gap between considerations on scientific and non-scientific knowledges. Trying to do so helps shedding some light on historical exchanges and communications between different means for groundwater detection. Recent ethnographic research in southern Europe shows, for instance, a surge of interest toward water-dowsing on the part of certain professional hydrogeologists (sometimes organized in associations) in spite of its lacking any scientific demonstration for its claims. This example also provides a way to relate such relatively circumscribed cultural shifts to socially much wider current changes in folk representations about water, fostering their better understanding by social sciences.

198. Erlend Eidsvik, Norway

Semiotics of a Sacred River. Signs and Meaning in the Holy River Bagmati

The holy river Bagmati in Kathmandu, Nepal, has for the last few decades become severely polluted. As the river flows through the densely populated capital, it is gradually reduced into a drain for industrial and domestic waste.

Even though the physical quality of the river has deteriorated, the ritual significance seems to be maintained, at least by some strata in the population. For others, the religious dimension has decreased, or even vanished. The meanings ascribed the river Bagmati in modern Kathmandu are stated in voices of ambiguity.

This paper intends to reveal the ambiguous meanings ascribed the Bagmati River among the population in Kathmandu today.

Identifying the different signs ascribed the Bagmati and further implement the signs in semiotic models is the analytical approach in this paper. A semiotic model illuminates the relation between an object, a sign and an agent (or interpretant, as Peirce states it). Hence is such a model a suitable model for studies in geography: An agent, embedded in society, gives the object (in the nature) a sign, which is a cultural expression based upon the agent's experience with the object in the nature.

The paper further discusses the process of mentalising the river, the process of establishing the river as a mental concept more than a physical river. The image of the primordial, clean and divine river is re-established, emphasising the river as a national icon, a manifestation of the legacy of Nepal in a religious, geographical and historical context. This process unveils different sets of metaphors, which again is derived from the signs ascribed the river Bagmati.

035. Evy Johanne Haaland, Norway

Take Skamandros, My Virginity: "The Ideas of Water" in Connection with Rituals Linked to Life-cycle Passages in Greece, Modern and Ancient

In modern Greece, several of the religious rituals are performed to ensure a person's health. They may also mark, and thus secure the transitions from one state of life to another. Therefore, pilgrims are still coming to one of the many springs found all over the country, and which are dedicated to Panagia, the Virgin Mary, to get Life-giving holy water. Caves with Life-giving water are also found in most of the churches dedicated to Panagia, such as the one on the Aegean island of Tinos. Here, people, particularly marriageable girls or newly married girls, fetch earth and holy water, both seen as very powerful fertility- and healing-remedies. This is particularly common on August 15th, the day known as the Dormition of

the Panagia.

In comparison, water was also an important fertility-symbol in ancient Greece. It may figure as both a female and male symbol. Among the images of water in religion and myths are the rivergods, nymphs of springs, gods and later saints, of water. The gods of the sea or ocean, Pontos, Okeanos and Poseidon, are male. So are rivers. Springs are Nymphs however and therefore female. The goddess of love and fertility, Aphrodite, was born from the foam, which gathered about the genitals of Uranos, when Cronos threw them into the sea.

The rites of propitiation to the nymph-spirits of springs are described by several ancient authors preserving ceremonies reflecting very ancient usages. Through the custom of offering a lock of hair to Artemis or Hera, and later to Panagia before marriage, we meet the ancient Olympian religion's and later the church's adoption of the cult of nature. Water and hair symbolize life according to the belief that water is a chthonic symbol and that a living individual's vitality is in her or his hair. So, the childhood is offered in exchange for the status as adult. Usually, girls have offered a lock of their hair to their native spring of childhood. It was often associated with a divine nymph, both a goddess of marriage and birth. The nymphs were believed to have the power of averting barrenness, and to promote offspring. Springs and brooks which they personified, also were held to possess this power. The water where they were worshipped had healing and thus, fertilizing power. The spring of water dedicated to the Nymph Kallirho' ("Fair Stream"), later was known as Enneakrounos (The Nine Fountains). On the wedding day, the Athenian bride and groom were given a ritual bath with water brought from the Kallirho' spring.

In many ceremonies, marriageable girls go down to a river and assimilate the life-giving waters by smearing themselves with mud, and girls in the Troad waded into the river Skamandros to wash off their virgin "wildness" with the words: "Take Skamandros, my virginity".

The paper will compare the importance of water in religious rituals linked to life-cycle passages in both modern and ancient Greece. In particular, the focus will be on young adults entering their majority and marriage.

126. Eva Jakobsson, Sweden

Understanding Lake Vänern. Perspectives on Europe's Third Largest Lake, 1600-1900

With its water surface of 5650 km² Lake Vänern is Europe's third largest and Sweden's largest lake. Lake Vänern has not yet had its history written. Perhaps this could be explained by the fact that historians find it unfamiliar to define a lake as an object for historical research - to discuss water bodies (rivers, aquifers, wetlands) as research objects. In a water history perspective lake Vänern is a physical, a mental as well as a social construction changing over time.

A lake could be described as a risk on one side, and at another as a resource. As risk themes one could mention shipwreck losses, floods and the lake as a recipient for towns and industries in the drainage basin. As a recourse Lake Vänern has for hundreds of years been a place for domestic as well as commercial fishing. The lake has also been very important for navigation. During the 1900's Lake Vänern became important for water supply, as a recreation lake (20 000 islands!) and as a reservoir for hydropower industry.

Beside these perspectives there is a further perspective - the scientific - which I will focus on in my paper. The paper derives from a larger project on the hydrological science history of Sweden that I have been working on for a couple of years.

The scientific topic longest discussed in connection to Lake Vänern is the question of the apparent, but unpredictable water-stage fluctuations (the lake can raise for a couple of years until it falls under some years). Over time different explanations, like an underground tunnel connecting to a Swiss lake, have been presented to explain these fluctuations. However, the key concept to make a solution of the dilemma was to place and define the lake in its drainage basin. The solution was the understanding and definition of the lakes comprehensive drainage basin, stretching out and into the Norwegian mountains. By its diffusion it contains different types of drainage regimes, making the water level fluctuation unpredictable. The interest for these water stage fluctuations, that have troubled riparians and navigation interest, has given us one of the oldest continuous series of water level measurements reaching back to 1807.

To find a solution of the flood problem scientist and engineers have discussed how to take control of the lake. Since 16th century a series of proposals with the purpose of lowering Lake Vänern or taking control of the outlet has been presented. The problem has still not found its answer. As late as last year, after some years of flooding during the 1990's, a tunnel from Lake Vänern to the sea was proposed.

040. Maheswar P. Joshi, India

History of water management in Central Himalaya

The present study purports to trace the history of water management in Central Himalaya in Uttaranchal, India, which was born on November 9, 2000, as the twenty-seventh State of India. It is situated between 28° 44' and 31° 25' north latitude, and 77° 45' and 81° 1' east longitude. This hills region is noted for being the source of several perennial rivers including the time-honoured sacred rivers of India the Ganga and the Yamuna. It is indeed unimaginable, but in reality the region under reference is witnessing grave water scarcity which is increasing year by year.

This essay is divided into five sections. The introductory section of the essay deals with the importance of water in traditional lifestyle of the local people as well as different folk practices using religious ideology to maintain watering places. It also describes various rites and ceremonies related to watering places together with peoples' belief in propitiating rain-gods for favour. Interestingly, these beliefs suggest that in the past Uttaranchal Himalaya received plenty of rainfall.

Section 2, "Traditional water management", incorporates archaeological, epigraphic, and archival source material coupled with ethnographic evidence to describe the traditional methods of water management in antiquity in which local communities and their dominant persons played vital role. It also mentions various local terms used in glossing different categories of waters as well as water harvesting devices.

Section 3 "Water rights in antiquity", based on the analysis of a vast corpus of published and unpublished inscriptional and archival records of the local rulers, describes as to how in antiquity the State used water management and the persons involved therein as an important factor in polity. These records also show existence of different types of watering places, natural and man-made, ownership of which was held by the State and, where necessary, their management transferred to individuals or other non government institutions.

The fourth section of this essay, "Discussion", brings into focus the importance of traditional water management system vis-à-vis the poorly conceived and executed modern hydraulic pursuits of the State government. It also shows that modern governmental methods of water management, although claimed to have been couched in scientific and coded legal norms, have aggravated water problems, because of the fact that while planning and implementing the schemes the authorities that be have not taken into account the local socio-cultural milieu of the area under reference. Due to corrupt practices resulting in poor quality construction most of these schemes have failed, and people have developed apathy towards them.

The last section of this essay contains notes, references and bibliography as par style adopted in the Current Anthropology. Although the focus of this study is the hills region of Uttaranchal Himalaya, it also draws upon inscriptional and archival sources bearing on water management in the adjoining Himalayan regions of Nepal in the east and Himachal Pradesh in the west for a comparative study. The study is first of its kind on the newly founded State of Uttaranchal, as it presents the available published and unpublished sources on water management of the hills region from remote antiquity to modern times at one place. Hopefully, it will help planners and decision makers in better understanding the burning problem of water management.

009. Giorgos Kallis, Greece

Co-evolution of water and urban development: Athens 1834 – 2000

Many histories of urban water development are describing either a "heroic" conquest of water by the advance of modern technology and economy, or cities growing beyond their limits, destroying communities and environments along the way. The concept of co-evolution transcends these two "mal-

adaptive" social and environmental determinisms, arguing that environmental and social systems change together, one affecting the evolution of the other.

In this paper I wish to reproach the relationship between city and water. Water does not follow nor determines the development process; rather, it is part and parcel of the urbanization process. The political, the social, the economic, the technological and the environmental can not be separated when one seeks to understand the evolution of water management. I document how the changes in Athens' water institutions, technological interventions and water works co-evolved with the patterns and institutions of the urbanization process, people's values and demands and the conditions of the regional hydrologic environment.

From a small village of 12,000 people in 1834 (year declared capital of liberated Greece) using local springs and wells, Athens is today a city of 4 million people, hosting 40% of Greece's population and consuming daily 1 billion litres of drinking water, bringing it from rivers as far as 250 km. Historians of the city see in the watering of the arid city an engineering "miracle" and the undeniable evidence of progress. In this paper I re-present the history of watering Athens as the outcome of both socio-ecological and political-economic transformation. The history of water supply is related to the history of the city as the conditionality of both arises.

Concluding, I revisit questions of urban water sustainability from a co-evolutionary perspective. The argument is that the question is not whether there is enough water to satisfy urban demands but rather to choose democratically between the alternative co-evolutionary urban-ecological futures and try as best as possible to approximate the process of change towards this vision. Concepts relating to the design of the institutional framework, citizen participation and empowerment receive renewed importance under this perspective.

018. Jörgen Lennqvist, Sweden

Birds in the backyard. The history of a non- planned development

The city of Örebro is situated at the shore of Sweden's fourth largest lake, Hjälmaren. The landscape was to a large extent changed when this lake was lowered 1.2 meter between 1878 and 1888. About 19 000 hectares of wetland was turned into agricultural land. The city was opposed to the project of draining because of its role as a harbour. Ironically the city came out as the great winner. Before the drainage, the city was restricted to the ridge. The lowering of Hjälmaren made it possible to develop the areas east and west of the ridge.

The lowering changed the fauna and flora of the lake Hjälmaren. The great catfish became extinct because of the destruction of the spawning grounds. The crane and the great snipe disappeared and the swan and the black-headed gull appeared instead. The western part of Hjälmaren had become a very shallow part of the lake with a depth of around one meter. At the outlet of The Black River, the largest inflow to lake Hjälmaren, a wetland area with a rather rich abundance of different species of birds had developed.

This area at the backyard of the city became a nature reserve. The development of this is due to the growing number of ornithologists during the 20th century. An important pioneer was Erik Rosenberg who arrived at the city as a boy in 1913. He soon developed a growing skill as a birdwatcher and started to campaign for a hunting prohibition in the area closest to the city. This was effectuated in 1921. During the next decades Erik Rosenberg lobbied for the city of Örebro to buy the land around the outlet of the Black River, the Os. In 1941 this was carried through. The city's reason for buying the land was the intention to construct a harbour for receiving oil. In 1943 the city council declared that the area that was not occupied by the harbour for oil would be protected as a park for the birds. The intention for the park was to create the best bird habitats that could be made and a park where interested citizens could take a walk and watch the wetland birds. Örebro financed the park but the work was made voluntarily by members of the bird watching associations. The members made plantations, clear cutting and other actions for the benefit of the birds. A couple of years later, a donation made the city the only landowner in the area, the Os was declared as nature reserve in 1968. The attitude towards the wetland area close to the city was slowly changing. The city dumps in the vicinity were closed down, the military training fields was to become owned by the city when the regiment was closed during the early 1990's. The area outside the nature reserve was cleaned and "face lifted" by the initiative of some of the city servants in leading position. The restoration of the area was done by labours of the community unemployment program.

The thinking concerning the wetland area close to the city of Örebro has changed during the researched period. At the beginning of the 20th century it was thought of as a useless and worthless piece of land. The ornithological use of land has always been coupled to modern society and its use of land. The drainage created the landscape. The community acquisition of land in the Os, in order to construct a harbour 1941, made it possible to let the other part of the area to be managed by ornithological enthusiasts. The restoration of the area outside the Os has been organised and managed by community servants. This kind of "inside activist" has been very important for the development of this area during the whole period of investigation.

064. Clive Lipchin, USA

Water, Agriculture and Zionism: Exploring the Interface between Policy and Ideology

Agricultural and water policy in the past 50 years in Israel has been heavily influenced by Zionist ideology. The central aim of Zionism and of the State of Israel is the creation and nurture of a Jewish presence within the geographical context of Israel/Palestine. In achieving this aim, Zionist and Israeli leaders have striven for the increase of the Jewish population through immigration and pro-natality policies, establishing a cooperative and rural mode of life, and laying claim to the land and securing peripheral areas through territorial settlement. Territorial settlement of the land by means of agriculture was considered a national goal for a continued Jewish presence in Israel. This policy might have had relevance during the establishment of the State but today it has left a legacy of mismanagement and environmental degradation. Agricultural settlements were meant to help disperse the population to peripheral areas and to provide an economic base for the country based on rurality and cooperativeness that served to bond the Jew to his homeland.

From this ideological perspective, policies were instituted that favored the expansion of agriculture and by extension, water development. All water resources within the country became the property of the state and a highly centralized system of water management, allocation and development was implemented. Nevertheless, throughout the history of the State agriculture has never fulfilled its ideological objectives. Today, crisis, conflict and acute water scarcity loom large in the region. In this paper I discuss the evolution and persistence of Zionist ideology in Israeli agricultural and water policy. The paper argues for a revision of Zionist thought that is necessary for sustainable management of existing water resources. Survey data on local perceptions of the importance of Zionist ideology with respect to water and agriculture are presented. These data were gathered from a representative sample of ten kibbutz settlements in the southern Arava Valley. The data provide a link between local and national perceptions. Results indicate that people still believe Zionist values pertaining to water and agriculture to be important at national, regional and local levels. Changing these perceptions will require not only political courage but local attitudinal changes as well.

013. Mahua Mukherjee, India

Water and Indian Architecture

The Indian Architecture and Town planning have evolved with time considering usages of spaces based on strong philosophical search. The first recorded history of human civilization in Indian peninsula is of Indus civilization (around 3000 BC). This was basically a utilitarian-urban society and showed practical wisdom of use of water as a decision-making element through site selection for habitat and designing storage and bathing tanks. Drainage and water supply was laid out to such precision, which can be regarded of high standard.

The Aryans, who came to Indian subcontinent around 1500BC, had started civilization again from the scratch and led nomadic lives in forests near rivers. Well-knit river networking provided them scopes for agricultural abundance and development of strong link to nature. Their experiences were expressed through composition of hymns in four Vedas. Both in Rig & Atharva Vedas, water had been conceived as the central focus of all creativity, fertility and prosperity. The role of water in keeping the creation continued had been expressed through water cosmology. Different symbolic forms guide the operation of water through its cyclical courses from ocean to sky and back (depicting seasonal changes, clouds, rains, snow etc.). The water cosmology recognizes the role of sap, semen and soma (sacrificial liquid- the source of vitality) in the lives of plants, animals, man and the Gods. This philosophy has influenced the

planning concepts, constructional details, elemental decorations, landscaping- all forms and expressions of architecture through ages.

The Mauryan dynasty, the first strong permanent government in North India, made huge impact on Indian Architecture. The Royal Capital in Pataliputra was designed within fortified palisades and was ranged along the banks of the Ganges like an immense castellated breakwater and was protected by a wide and deep moat with aquatic plants and ferocious water animals. Since then, there are many examples of Indian architectural splendours, which used water as design element. In Temple architecture (both in North and South India) water tanks have been part and parcel of rituals and designs. The Ghats (interactive, transitional spaces between river and land through series of steps) are the traditional architecture with a definitive form, which till date dictates any riverfront development along Indian rivers. The Fort architecture is an old concept in Indian scenario. With time the constructional material has been changed but the very purpose of fortification (i.e. security and service during emergency/ attack) had been fulfilled with water (as moat and storage tanks). Kautilya had chronicled different ways of fortification long back. Scarcity of water has made several forts inhabitable. During Islamic period water element has contributed in many other different forms like in gardens, palaces, tombs etc: e.g. Shalimar garden, Udaipur Lake City palace, Jahaj Mahal etc. The background of river Yamuna enhanced the quality of the space in Taj Mahal.

The objective of the present paper is to present the impact of water on the built and semi-built form in Indian subcontinent in chronological order till date. In future it may be the starting point of in-depth study on this link between water & Architecture in Indian context.

162. Nefissa Naguib & Mariken Vaa, Norway

Models and Realities in Domestic Water Supply

The United Nations International Drinking Water Supply and Sanitation Decade (1981 – 1990) ended in a global consultation where experts from 115 countries agreed on the following guiding principles for water development:

- Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes.
- Institutional reforms promoting an integrated approach and including changes in procedures, attitudes and behaviour, and the full participation of women at all levels in sector institutions.
- Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes.
- Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies.

These principles summed up insights gained from the high failure rate of earlier water development interventions, where water supply was primarily seen as a simple task of engineering. They have in various forms been endorsed by both donor and recipient countries' governments. To what extent they are actually guiding the practice of developing countries' sector institutions and donor agencies is not well known, but probably variable.

This paper discusses some of the main political and institutional reasons why developers rarely choose appropriate technologies and often fail to ensure the involvement of women and community management of services. This provides the background for an in-depth study of a village in the Palestinian highlands. Here the provision of piped water to households, although welcomed, has had unexpected consequences for the lives of women. The established picture of Third World women's subordinate position within their households and communities is challenged by the images these women have of their chores of managing 'their' household water. In this patriarchal society, domestic water supply involved the entirety of women performances and experiences. The complexities of this specific case imply that water development is not as straightforward as is often assumed. Development interventions in domestic water supply aimed at empowering women need to integrate existing institutions as well as local knowledge.

019A. K. Shadananan Nair, India

Historical Changes in Transboundary Water Disputes – A Case Study from India

One of the greatest challenges in water resources management today is the amicable settlement of disputes over water. In India, the transboundary water disputes after the independence have slowed down many development projects with serious impact on the agriculture-based economy and life of the millions. There exist several disputes over water sharing, among different states and different users, the oldest and the most severe issue being the Cauvery water dispute between the south Indian states of Tamil Nadu and Karnataka, dating back to 1807 between the then princely States of Mysore (present Karnataka) and Madras (present Tamil Nadu). The river originates in Karnataka and flows east through Tamil Nadu to join the Bay of Bengal. Agriculture in the rich fields of Tamil Nadu depends largely on Cauvery water. The issue started when Madras opposed Mysore's plan to construct a dam in Cauvery, arguing that water flow to agricultural lands in Tamil Nadu would decline and this ended in a war. In 1924, a 50-year agreement for sharing water was signed. After its expiry in 1974, political leaders failed to solve the problem and a tribunal was appointed by the Supreme Court of India in 1991. Orders of the tribunal or the court could not be effectively implemented so far, because of widespread protests. The situation is relatively calm when the monsoon rainfall is strong and the issue becomes severe when the monsoon fails. Tremendous increase in water demand associated with fast increasing population and degradation of land and water resources has been exerting more pressure on the river, adding more fuel to the burning issue. In this paper a review of historical changes in hydrological conditions and disputes in the catchments of the Cauvery and the attempts for conflict resolution have been made. Changes in water availability due to the effect of population growth during different periods in the last century have been estimated. Some guidelines for conflict resolution in view of a changing environment have been presented.

068. Terje Oestigaard, Norway

Ganges and Kali in Bangladesh: The waters of life and death

There are two types of Mother Goddesses in Hindu Bangladesh - one gives life and the other takes life. Kali is traditionally seen as the Goddess of Death and destruction and Ganga as the almighty life-giving Mother of the World. The annual floods in Bangladesh are a re-occurring problem, incorporated into the low-religion of common people who consider water and death to be associated with the taking and creation of life. Each year the river kills people and destroys the land, but the river and floods are also pre-requisites for a successful harvest and further life. Kali statues in particular, but also statues of other gods and goddesses, are seen to "die" each year when the divine spirit leaves the statue. These statues are seen as dead bodies and given water burials in Ganga, thus uniting the micro- and macro cosmos, nature and culture. The uncertainty of the environment is incorporated into the goddesses of life and death; too much water or too little water are seen as wrong waters for life. The imageries of the goddesses Kali and Ganga are related to life experiences of the devotees who worship them where personal life experiences are culturally incorporated in the divine and changing water environment. The aim of this paper is to explore the importance of water as a life-giving cultural force in a changing environment. It will ascertain why statues of goddesses are buried, why there are both nutritious and terrifying Mother Goddesses, and establish the importance water has in similar cultures and religions. Moreover, it will highlight the mutual dependency of life and death, sacred and profane, culture and nature, and establish water as medium which unites and bridges cosmological spheres.

050. Amreeta Regmi, Nepal

Democratizing Technology: Interfacing Electricity Generation and Water Use in Nepal

As the global water resources become more and more precious, the search for a nexus between water and energy also heightens. Professionals in the arena of science and technology, therefore, are always on the look out for a meaningful contribution that can promote effective linkages between water and energy. In congruence with this global search, the water and energy sector of Nepal, too, is exploring such a contribution. During the past few years, combing for adaptive design choices that fulfill community's electricity and water needs has been the objective of mainstream discourses. Nepal, with its unrealized potential of colossal water wealth, presents an appropriate subject of such discourses.

Within the domain of interaction between science, technology and water resources, the primary element,

water, itself is said to be a politically contested resource. Supporting this argument, practices from the field illustrate that 'electrification', as intrinsically linked in the field of water resource management, also becomes both implicit and explicit representations of the contested resource itself. Various models of electricity generation and rural electrification from Nepal seemingly point towards two distinct models $\frac{3}{4}$ the dilemma of the macro versus the micro hydropower development, the grid versus the non-grid and the urban versus the rural classification of technology. On one hand, only about 5 per cent of Nepal's rural population have access to electricity and, on the other, the country is negotiating on the sharing of its power surplus of over 112 mega watts with its power-and water-hungry neighbour, India.

This paper, first looks at the linkages between water and energy, and then presents the history of hydropower development and rural electrification in Nepal. By citing some examples from the central hills of Nepal, the paper then, describes the concurrent design models of rural electrification. Translating insights from the social construction of technology, practices from the field illustrates that the rural electrification and technology development in Nepal represent expressions of heuristic contours. A closer look at community oriented micro hydel systems, reveals, that these contours shape the relationship between water and energy, evidently signaling a two-fold nexus between the elements. Based on empirical findings, this paper concludes that the interface between power generation and water use is a sociotechnical interaction that operates within the realm of hydraulic and human processes. I argue in this paper that these two sociotechnical processes of a design ensemble define the relationship between water and energy and shape the technical freedom of technology. I conclude by examining the interfaces to reflect upon how design systems could be integrated, to include those without access to electricity, and thus promote democratization of technology.

097. Parag Sadgir & Ashok Vamanrao, India

Water in Vedic Literature

The universe is constitutive of five basic elements; kshiti (earth), apah (water), tejah (light), marut (air) and vyoma (ether). According to RigVeda, all life is evolved from apah (water). Water is the first need of living creatures in all ages and it is regarded as one of the basic factors for human existence. Without it life on earth will cease to exist. Water means 'pranic force' of a living organism. It is one of nature's major limits upon the human and other organic population of the world being required at the right place, time and of right quality. Vedic literature contains the idea and awareness regarding environment even though in a crude form. They also had some primitive but certainly significant devices in their mind to protect the natural resources from the human onslaughts. The large references exist in vedic literature about medicinal aspects of water, feelings about apah (water) and preservation of water with use of different naturally available plants for removal of impurities. Pure water is termed as 'divyajal' due to following properties; Sheetham (cold to touch), Sushihhi (clean), Sivam (should has nutritive value requisite minerals and trace elements), Istham (trasperent), Vimalam lahu Shadgunam(its acid base balance should be within normal limits). Charak and Sushruta classified water in major groups; atmospheric water and ground water. Atmospheric water is classified as Dharam (rain), Karam, Tusharam and himam.

In these literatures, they have mentioned about use of water and qualities of water. Purification of ground water in the dug wells is discussed in Briht-Samhita written by Varahamihir. He suggested an infusion made from a mixture of powdered herbs; Anjan, Bhadramustha, Khas, Gilki, Amla and Nirmali in water and measured volume of which further added into well waters for purification. Detailed practical guidance for water purification is given in the famous treatise of Indian sage, Sushruta. Among the seven modes of purifying water, Sushruta teaches that muddy water should be clarified with a natural herbs; Nirmali seeds, roots of Kamal, Rhizomes of Algae and three stones; Gomedmani, Moti, Sphatik and he recommends the disinfection of contaminated water by exposing it to the sun or immersing red hot iron or hot sand in it. All the different references in vedic literature regarding water and their effects is discussed in the paper.

186. Elmarie van der Schyff, South Africa

The Nationalisation of Waterrights: Derpivation or Expropriation? A South-African Perspective

South Africa's water law dispensation has changed dramatically with the promulgation of the National Water Act 36 of 1998. The previous distinction between public and private water has been abolished and the Minister of Water Affairs and Forestry has been appointed to act as trustee of the nation's water

resources. Through the working of section 4(4), exclusive rights of water use, which were in force before 1998, were replaced by water allowances, granted in the discretion of the relevant authority. The key issue, which is investigated in this paper, is whether the state, through the provisions of the National Water Act, expropriated vested rights in property or whether such infringement merely constituted a deprivation.

The new concept of property in terms of section 25 of the Constitution of the Republic of South Africa and the distinction between deprivation and expropriation are examined. It is indicated that the concept of property in South African law has been extended to include not only ownership but also rights in property. Although no definition of property has been formulated in the Constitution, it appears from applicable authority, that this development in the law of property is supported by the Constitution and that the protection granted by the property clause will stretch as far as the inclusion of rights in property. It is for this reason that the existing water use rights, which were available to certain individuals in terms of the 1956 Water Act, can be classified as property.

Section 25(1) authorises the infringement of private property in certain defined instances. Despite the many academic works which define the difference between deprivation and expropriation as described in section 25(2), the Constitutional Court clarified this matter in *First National Bank of SA Ltd t/a Wesbank v Commissioner for the South African Revenue Services 2002 7 BCLR 702 (CC)*. Expropriation is described as a sub-category of deprivation. Section 25(1) must thus be used as the starting point in all cases in which an investigation is conducted into the constitutional validity of an infringement of property. Only when it has been established that the requirements of section 25(1) have been complied with, is the question of whether deprivation constitutes expropriation, asked. The requirements for deprivation, expropriation and inverse condemnation are discussed with reference to applicable case law.

After the aim of the National Water Act was weighed up against the disadvantages which individuals suffer through the infringement of their vested rights, the conclusion was reached that the nation's need for sustainable water resources carries more weight than the individual's exclusive right of use of water. A constitutionally valid deprivation has thus occurred. Due to the fact that the state did not appropriate any rights in this process, the conclusion was reached that this provision does not amount to expropriation. It does however appear that the provisions of the National Water Act can give rise to inverse condemnation or constructive expropriation in specific circumstances.

Key words: National Water Act, Property, Expropriation, Deprivation, Inverse condemnation, Ownership

173. Hani Nabhan Sewilam, Germany

Modeling in Water Resources: Form Numerical Methods to Computing with Words

Mathematical models have long been known as powerful tools to solve water resources problems. Most of available models are crisp, deterministic and precise in character. However, many of water related problems are ill-defined (e.g., ecohydrological processes, human behavior) when the only available information consists of expert knowledge, which is formulated by words from natural language. Also developing of decision systems to support integrated water resources management faces great difficulties not only because of the interrelationships between technical, economical, social and environmental aspects but also due to the difficulties of participating ecologists, economists, sociologists and hydrologists in the modeling process. For example, while ecologists use natural languages and qualitative reasoning for the description of ecological relationships, hydrologists communicate in the form of systems of differential equations or analytical models. Unfortunately, numerical models are not well suited for dealing with uncertain situations or qualitatively described processes.

Computing with words (CW) is a modeling technique in which words are used in place of numbers for computing and reasoning. Fuzzy logic is the core of CW, it enables to transform these expert words into numerical models with less efforts and low cost. Recently Artificial Neural Networks have been introduced to fuzzy logic to form so called NouroFuzzy System which exploits the strengths of both techniques best while reducing their weaknesses. A numerous number of applications worldwide are already existed, however water specialists are still relatively out of competition.

This paper will scope on the limitations of traditional numerical models and the need for CW as a new modeling trend in water resources to deal with uncertainty, partial truth and qualitatively described knowledge. The basic principals of different CW-techniques will be illustrated with examples for their applications. The possibility to link together experts in different disciplines to solve water problems using a CW-based common modeling language will be discussed.

Keywords: Modeling Techniques, Water Management, Fuzzy Logic, Artificial Neural Networks, NeuroFuzzy Systems

104. S. Shanmuganandan, India

The History of River Ganges in India and Its Impact on Civilization

The Ganges River has always been known as a religious significance in India. The Ganges River is over 1557 miles long and flows through Bangladesh and most of India. The River is known for its spiritual importance because the people of India rely on the river for most of their life functions in the area. The uses of the river in India are nearly endless; the main functions of the river are Agricultural use, Industry, as an energy source, transportation, Drinking, bathing, and baptisms. The Gangetic river alluvium is rich in fertility and the surrounding soils are very good for agricultural uses. The flooding of the river greatly enriches the nutrient content in the soil. Along the river there are many industries such as textiles, paper, leather, and many more who use the water for power, cleaning, etc. Both people and industries use the hydroelectric power generated from this river. The river also serves as a drinking source, bathing hole and baptism sight. The river is one of the major drinking water sources for the people of India and hence they can't afford running with polluted. At the same time, due to religious and spiritual reasons, over 10 million people who bathe in the river daily use it as a mass-bathing site. These people who have diseases and very poor hygiene cause the river more polluted.

This river is also used a baptizing sanctuary, and burial hole. Babies are baptized in the river because they believe it cleanses the child, also when a person dies and the dead body is cremated and their remains are released into the river for the same reason, because they believe it cleanses the soul. The present study attempts to analyze the history of the Ganges river in the last few decades in relation to its importance and cultural values of Hindu life and its impact on human civilization particularly with reference to mass bathing, cultural way of life of people and also the impact of human dimensions on water quality of the river. The study also probes in to the water quality of the Ganges river and also on water pollution caused by various sources. An attempt is also made to find out the major dimensions on the significance of the Ganges River and water resources potential in relation to water quality and river water resource management. The study is based on the secondary data and analyzed with the help of multivariate statistical technique. It was observed from the study that the Ganges Valley, or basin, is 200 to 400 miles (322 to 644 km) wide The River starts in an ice cave on the southern slopes of the Himalayas, some 10,300 feet (3,140 meters) above sea level. Sheer volume of waste - estimated at nearly 1 billion litres per day - of mostly untreated raw sewage Also, inadequate cremation procedures contributes to a large number of partially burnt or unburnt corpses floating down the Ganga, not to mention livestock corpses

082. K.N. Sharma, India

Unique Ideas on Water in Ancient Indian Scriptures and Culture

Water has been an oracle for divination cosmology in the ancient Indian thinking and wisdom. Vedas, the most towering monumental scriptures ever possessed by human race contain, inter alia, some important ideas on cosmology. Water regarded as the first and the foremost element in the Vedas, is believed to be the original creation and the foundation of all in the universe. It symbolises the original fountain of life which precedes all form and all creation. Many myths and legends are also based on a concept of there being a primaeval ocean or watery abyss which was the source of all life.

The subject of water has been vividly treated spiritually, philosophically, cosmologically, medically and poetically in the ancient Indian literature. Water occupies the highest place amongst the five basic elements of Nature, called 'Bhutas'. The substance capacity in the five Bhutas manifests in the following order — Akash (Ether, Space), Vayu (Wind), Tej (Light or Fire), Aap (Water) and Prithivi (Earth). According to one school of thought, the empirical world is constituted of the imperishable atoms of Prithivi, Aap or Jal, Tej or Agni and Vayu. They also enumerate Ether, Time and Space with them. Water was said to be formed from the space; fire and wind from water, and the earth was formed from their reaction. Water and fire which are said to pervade the entire universe, have a close nexus and possess procreative powers. While the waters have been regarded as the mothers par-excellence, the fire has been considered as the prolific generator and begetter. The tripartite nature of Agni has been connected with the three forms of waters - celestial, atmospheric and terrestrial.

The relationship between man and the universe has been a most fascinating idea that attracted the mind of thinkers in almost every religion, philosophy, mythology, and ritual from primitive age to modern time. The seers of the Vedas have often wondered at various phenomena in the universe, pondered over the marvels of nature and attempted to unravel the enigma of creation. Amazingly, most of them are corroborated by the modern scientific theories.

Water had a unique status in the ancient Vedic scriptures and still enjoys the highest place in the socio-religious culture of the Hindus. The rivers are revered as mother goddesses and their waters have been described as life giving, purifying, food providers, ambrosia and alike. Immersion in waters of the holy rivers is believed to revive the life force and is used in ritual as a means to spiritual rebirth. In this sense the water signifies a return to a primordial state of purity.

The paper attempts to review historical ideas on water and rivers as contained in the ancient Indian scriptures, to their place in the present day social, cultural and religious traditions of Hindu societies.

181. Devarshi Kala Nath Shastry, India

Water in Indological Symbology

Right from the Vedic times, water has been a source of inspiration for the creative writers in India. In the Vedas, water has been seen (1) as one of the primal elements (Apas, as the first tangible element in the universe), (2) as a life-sustaining resource, the sources of which have been enumerated vividly, e.g. glaciers, oceans, skies (rain water), the earth (subsoil water, surface water), the dew etc. and (3) as denotant comparant (Upamaana).

Oceans, rivers, rains and perennial, ephemeral and transient streams have extensively served as the symbols and comparant images for different states of life, situations, moods and attributes of human nature. The study of such imagery can be of interest and pragmatic value. The oceans have always stood as a symbol of three attributes – depth, wealth and magnanimity. The sea never transcends bounds and serves as a symbol of discipline (Maryada). In ancient Indian literature, Lord Rama has been compared to ocean (Samudra) by Valmiki for his sobriety and magnanimity. The ocean is also called a jewel-mine (Ratnakar) and a source of wealth. In the Vedas, the rivers stand for regular inflow of wealth and prosperity.

A mystic connection of water with the moon has been construed as an inexplicable bond between two distant entities attracted towards each other. The spring and neap tides in the seas are believed to be caused by the moon. These lunar phenomena serving as symbols have inspired many a poet over the millennia to create images of love and bonds of affection. On the imagery of spring tides, rising waters of the sea have been compared with the emotional upsurge. Different rivers of India have become symbols of different attributes -- most prominent being the Ganga, standing as a symbol of pristine purity and divine sanctity, Narmada of virginity, Sone of virility, etc.

Water as the purifier, has served as a symbol of firm resolve also: it is an invariable substance used in all religious resolves (Sankalpas), as also of oblation (Tarpana) -- being a thirst quencher. In the Hindu temples, after the final 'light offering', i.e. waving of lights around the images of the Lord, waving of water has also to be performed and a throwing (sprinkling) of water drops over the devout spectators attending the congregation is an essential part of the ceremony. Water has also been regarded as the 'destroyer'. The concept of cataclysm (Jala Pralaya), regarded as the last deluge brought about by the stormy and turbulent waters as the final cataclysm resulting into the end of the creation.

Various sayings, beliefs and images connected with water have been regulating the communal life of the Hindus in India. For example, after a child birth, the worship of water (Jalwa or Jal Poojan) is an essential ceremony, just as after a marriage and after a pilgrimage the worship of Ganga or a holy dip in its waters is considered to be an essential requirement. For oaths in the courts, Ganga water is used to vouch for honesty and truthfulness of statements. As a totem also, water has been used in the post Vedic India for cursing a person. The sages took some water in the palm and dropped it while pronouncing a curse on the sinner.

This paper attempts to discuss this new aspect and bring forth salient historical features of the concepts, beliefs, ceremonies and images related to water in the ancient Indian literature.

184. A.S. Solanki, India

Historical and Socio Economic Background of Inter State Traditional Drinking Water Management System in Dry Western Region of India.

The rainfall pattern in dry western region is quite erratic and uncertain. The dry Western region is included Rajasthan and a part of Gujrat S tate of India, where rainfall is extremely low and range between 200 to 300 mm per year. The formidable Thar and Kach dry region spread over 61 percent area of the state and covering 3.5 lakh square kilometers. It is a extremely different situation for population to survive specially for drinking water. The historical data has shown that the old Kings of the region constructed several alternative sources of drinking water like Bavri, tanka, nadi, talab's etc. Out of this "tanka" is very famous Kaccha structure made by every households in the region. This situation arisen due to the fact that the perennial rivers flow Rajasthan to Gujrat. The historical data showed that even Rajasthan people did not get drinking water. This also arisen interstate water conflicts. A detailed analysis was done to review the historical background of flow of river water (river - Bandi) from Rajasthan State to Gujrat and conflicts arisen, the solution suggested in terms of tanka and their economic impact at both state economy as well as at household levels.

B. The History of Water: Science and Technology

171. Meriam Addou & Ahmed Benhammou, Morocco

Water and Wastewater in Morocco

Morocco is characterised by very marked regional disparities as well concerning relief, climate, precipitation volume that concerning water availability. The north hydrological Watersheds are very favoured as regards water resources compared with chronic deficits raised in south watersheds.

On the 150 billions m³ representing the yearly precipitation, only 30 billions m³ flows out in surface or infiltrates to either form or feed groundwater; the remainder being lost by evapotranspiration. If one deducts losses by evaporation, uncontrollable out-flows toward sea and desert, the hydraulic potential available at the current technical and economic conditions rises to 21 billions of m³ on average yearly, which 16 billions of m³ from the superficial resources and the remainder from the underground resources. The main users of water are irrigation and water supply. At the 2020 horizon, several watersheds will present a large water resources deficit. Therefore, it is programmed to achieve several works (dams and drillings) in almost all watersheds that guarantee an available resource on the order of 15,5 billions of m³. Waters of the existing dam whole are generally good quality. Superficial and underground waters quality varies from one watershed to another, it is from very bad to good. It is due to the direct discharges of cities and industries as well as to the infiltration of irrigation waters charged in nitrogen in groundwater.

Wastewater treatment remains the component that knows the more of backwardness. About fifty Wastewater treatment plants has been constructed since 1958 in Morocco. More than 80 percent of those plants are now out of service. This problematic shows the management failure of the local communities as regards sanitation.

One assesses costs of natural resources deterioration to 20 billions, that is 8,2% of the national GDP. This deterioration has an ominous impact on the socio-economic development of the country.

006. Imad Abdul Majeed Allawati & Saud Salim Al-Kindy, France/Oman

Costumes and Regulations Controlling Water Distribution in Aflaj Systems: Case of Falaj Daris in the Interior Region of The Sultanate of Oman

The Aflaj (singular: Falaj) are canal systems that provide the village and the community with water for agricultural and domestic uses in the Sultanate of Oman and in the neighbouring countries. The Oman Royal Decree no. 3/97 defines the Falaj as "a subsurface or above surface canal that collects the groundwater, the spring water, the natural spring water, or the water of the floods and diverts them to different locations. and uses them for different purposes". The Falaj is one of the sustainable irrigated agricultural systems that is well adopted to dry conditions in the Arabian peninsula.

Many methods were followed in distributing and using canal water. In the Falaj system, water rotational method with a fixed interval (locally named Dawaran) is being followed. The basic water quota unit (locally named "Ether") is fixed to be not more than 30 minutes. However, irrigation schedule varies from one Falaj to another.

Falaj Daris at Nizwa (Oman interior) is one of the most important Falaj in Oman. Its high discharge and the size of command area in addition to its location makes it of great importance. The area irrigated by the Falaj is divided into two main zones; upstream zone, Allayah which consumes about 54% of the Falaj water and the area downstream; Safalh with percentage of water consumption of 47% of the total Falaj water. Farmers follow several practises to secure water for their crops dominated by date palm.

This paper discusses the Falaj system in general with special emphasis on the distribution methods followed by the Falaj owners. In addition, it describes the regulations and the customs that control water distribution in Falaj Daris in the interior region of Oman. It also focuses on the approaches that maybe taken to improve on-farm water management. The paper shows that there are potentials for increasing the irrigated area provided that some improvement is made to the current system to increase the efficiency of water used at the farm level.

191. B. Al-Salman & H. Ghoneim, Kuwait

Historical Perspective of Water Supply in Kuwait

Groundwater is a precious water source everywhere in the world, particularly in Kuwait, which is characterized by extremely arid conditions. This paper is presenting a historical perspective of water supply, ground water production and consumption.

Prior to 1925, rain water and shallow wells were the main sources of water. Between 1925 and 1951, Water was imported from Shatt Al-Arab, Iraq, to meet increasing demands. In 1951 a public water supply service was established and managed by the State, with seawater desalination and underground brackish water as the principal sources of water. In 1951 Kuwait oil company started installation of a small desalination plant in Mina Al-Ahmadi brought the utilization of water from shallow wells and Shatt Al-Arab to an end and opened a new era in modern water supply.

The accidental discovery in May 1960 of fresh water at Raudhatain gave additional impetus to initiate groundwater investigations. The Parsons Corporation, U.S.A., was engaged to investigate this area and develop a production well field. Another underground water fresh water field was developed at Umm Al-Aish almost in the same time.

To meet the increasing demand for water, new distillation facilities were progressively installed. The impressive development of this source is represented by the year (1986) production of 175,997.7 million l/yr (38714 million gal/yr) and maximum consumption of 582.8 million l/d, (128.2 million gal/d) compared with 1,118.3 million l/yr (246 million gal/yr) and 3.36 million l/d (0.8 million gal/d) in 1954 (MEW, 1987).

Realizing the importance of the rational management of the groundwater resources of the country, the Kuwait government is sparing no effort in the search for alternative sources of water to supplement the groundwater resources in an attempt to prolong the life of this important entity. One of the important sources of water that can be considered in this regards is wastewater. This source of water can be utilized efficiently to meet the growing demand on water in the country. In Kuwait, there are presently 3 sewage treatment plants.

047. G.M. Badaranayake, Sri Lanka

Socio-ecological Significance of the Village Tanks (small reservoirs) Systems of Sri Lanka. A Study of Society Water and Environment.

Sri Lanka is a tropical island located in the Indian Ocean. It's climate is mainly determined by weather patterns of South-Asian region particularly by two monsoons called Northeastern and Southwestern. The South-west monsoon rainfall brings a higher amount of water for the western part of the island but less rainfall to the northern part called Dry Zone. North-east monsoon brings a little or no rainfall frequently. As these monsoons confine to a very limited seasons(two or three months) the most part of the year experiences lack of water. Limited water, available on the surface is mostly subjected to evaporate due to high temperature throughout the year. When either one or both monsoons are failed, there would certainly be dry spells or droughts those seriously effect the environment as well as the societies whose socio-economic activities are entirely based on water. Thus water is a limited, valuable and scarce resource in the Northern Dry Zone of Sri Lanka where a large number of rural communities live depending on irrigated agriculture. In the early times of the inhabitation the country, there was a hydraulic civilization based on a very sophisticated irrigation and water management systems called Village Tank (small reservoirs) System. Since very beginning of the civilization, people have built and improved this water utilization system to overcome the problems of water scarcity. Tanks were built by damming the rivers and streams across at many places in order to collect, reserve, regulate and to use water in a sustainable manner. Village tank system, in it's technical and hydro-meteorological aspect has a unique significance. A tank is not a single component but a component of a well planned integrated water draining system made by the man called the cascade. Cascade is a chain of reservoirs located along the streams or tributaries of a river within a macro catchment or a watershed. Every tank connects to another by the same stream. Surplus water from one tank located in the upper part of the stream, flows to the other that is located in the lower part of the stream through the irrigation channel network on the paddy field. Ultimately water collected into a larger reservoir located in the lowermost the valley (fig 1). Every tank has a settlement called village, located in close proximity to the tank. Settlement is consists of about 50 to 100 dwells belong to a few families who ever engage in cultivating the paddy

field. They mostly belong to a single cast and expanded from a one or two nuclei families. The paddy (rice) field is located just below the tank lying parallel to the stream. Paddy field is used mainly for rice cultivation by irrigated water issued from the tank. The upper part of the tank's water spread area is normally covered with forest, mostly with jungles or dry scrubs. People use this land for highland cultivation known as Shifting cultivation or locally called Chena cultivation. This land is also used for timber and firewood.

In terms of physical set up, village tank system is not only a water regulating system but also a better man-made adjustment to the environment of dryness in the Dry zone of Sri Lanka. It directly effects the soil, vegetation, surface and ground water, air moisture and bio-diversity of the environment. Tanks play a vital role in reducing the dryness of the air, adding higher amount of water vapor in to atmosphere by evaporation from the water body. Present study reveals that the atmospheric humidity in tank villages are considerably higher than that of the outside area. Natural environment surrounding the tank village system particularly dense vegetation cover around the tanks, along the streams and irrigation channels have created a micro-climatic condition. It has been mostly favorable for the bio-diversity. The people who lived in these environments achieved and gained many advantages from this environment. There was a good relationship between man water and environment. The tank is the main source of water. Their social economic activities and culture was entirely linked with the tank. Sociologically, in these societies there were so many traditions, customs habits and attitudes in relation to the utilization of water. Their water utilization methods and practices have been entirely based on such attitudes. They are tightly bounded with the protection of the environment.

Placing an especial emphasize on the above mentioned conditions, present paper discusses the importance of the interrelationship of man water and environment in the Dry Zone of Sri Lanka from an ecological perspective. In this attempt, the present paper deals mainly with three aspect as follows

- 1 The physical set-up of the tank cascade system and it's environment, particularly hydro-meteorological significance
- 2 Sociological aspect of the utilization of water as a scare resource
- 3 Linkage of man water and environment

In the first step, physical set-up of the Tank Cascade System is analyzed by the method of Ariel photographs interpretation. It's hydro-meteorological significance will be analyzed by data, collected from recorded sources as well as from the field research undertaken by the author. Sociological aspect will be discussed on the basis data and information collected in the field by social data collecting methods such formal and informal discussions with people and study of life events. Linkage of man water and environment will be identified by utilizing both physical and social information. The ecological significance of the social activities of village tank societies will be highlighted ultimately.

078. Arash Barjasteh, Iran

The Site Geology of the Historic Hydraulic Structures around Shushtar City, Iran

Shushtar City being located at north of Khuzestan Province, is one of the most ancient cities in Iran and has a few number of historic hydraulic structures dating back to nearly 2000 years ago. Being called as Shushtar hydraulic ring, it is consisted of 8 dams, weirs, bridges and mills, all of them were constructed over Karun River. Regarding their significance as agricultural, economical and tourist elements it has been known to be necessary to repair and rehabilitate these structures to prevent them from more destruction. In this paper, the geological and geo-technical characteristics of two of the mentioned structures namely Gargar weir and Daryun tunnel are presented. Both of them were constructed in Agha-Jari Formation of Pliocene Age and suffered some damage due to various reasons. The formation consists of an alternate of sandstone and marlstone layers, the former is moderately grained and relatively well sorted. The average dip of bedding plane is 5 NE and two main joint sets trending N 40-60 E and N 40-60 W with nearly vertical dip and a bedding parallel one have cut the beds. Regarding structural nature and results of geotechnical studies, the tunnel walls of both structures are almost stable however, erosion of marly layers at water contact specially downstream, and solution of clayey lenses within sandstone layers caused some collapses. The permeability of sandstones and marlstones were measured as 1 to 15 and 0 to 30 Lugeons, respectively. In addition, their durability indices are 77 and 36 percent on the average, respectively. It must be noted that seepage of sewerage system and heavy vehicles traffics amplified collapse. Wholly, regarding to the investigations and considering archaeological limitations, some treatments including rock fill retaining walls, timber trusses and very limited trimming have been done to stabilize the tunnels.

137. James D. Birkett, USA

Advances in Seawater Desalination, 1800 –1900

During the 19th century seawater desalination progressed from being a highly energy inefficient curiosity to becoming far more efficient articles of commerce, manufactured in several countries to established designs and employing several distinct technologies. Progress was largely driven by market-pull rather than technology-push, although it also benefited by technological developments in other industries. This paper will touch upon:

- § Advances in technology
 - o Multi-effect evaporation
 - o Mechanical vapor compression
 - o Thermal vapor compression
 - o The use of solar energy
- § Parallel and relevant advances in pure and applied sciences
 - o Properties of water
 - o Properties of steam
 - o Thermodynamics
- § Applications
 - o Marine
 - o Land-based
- § Florida
- § Chile
- § Malta
- § Aden
- § Etc.
- § Manufacturers
 - o England
 - o Scotland
 - o France
 - o Germany
 - o USA

At the end of this period, desalination equipment in a range of sizes could be purchased from a number of suppliers. It would however be another 75 years before reliability and operating economics improved sufficiently for it to achieve widespread applicability.

160. H. Walter Cazenave, Argentina

The "Artesiano" Ditch: A Technological Resource which Changed Society and Economy in the Pampas.

The big development Argentina had during 1880 and 1920 was based on its cattle first, and on its agriculture later on. Given the excellent environmental conditions in the Pampas, cattle existed at least since three centuries ago, though quite bounded by lack of suitable improvement technologies. The main obstacles were two: 1) handling difficulties in cattle inclosure; 2) watering safeless permanence.

The first of these problems was solved by the wire-netting introduction, near 1850, but water problem remained, especially in the west, on indians lands. Cattle inclosure proved to be useless in a region like the pampas, alternatively subdued to droughts and floods.

Beverage and animal permanence were secured as long as there were surface waters: lagoons, rivers and streams; but as they diminished its flow or got dry, it was necessary to get rid of cattle not to lose money. Besides, the dug ditches which allowed subterranean layers were unsafe, non practical and difficult to dig in regions where rain was less than deep water.

With the first "artesiano" ditch hydraulic development changed definitively cattle management and development, and its associated industries or activities. An outstanding success --not very well remembered by the way-- took place in 1862, when the french Adolfo sordeaux extracted water in Buenos Aires province using the artesian ditch. This success, added to the wind-mill appearance, coming from U.S.A. in 1880, allowed a fast and deep cattle frontier displacement: more than 800 km westwards in twenty years, making of a rudimentary pastoral society one of the world richest meat producer region.

039A. S. Indranat Chakravarti & Santosh Gosh, India

Recycling of Wastewater in Cities - Traditional Indigenous Technology: Calcutta

1. Introduction

Recycling and reuse of waste water are in practice since ancient times. Due to water scarcity recycling becomes a major component in water management. Sewage and waste-water fed fishery is being developed in many countries and Calcutta has the largest recycling district in the world.

2. Historical perspectives in Calcutta

The objective of Calcutta case study is to focus attention on the indigenous system of reuse of waste water after recycling and treatment for potential benefits with peoples' own management. The eastern side of Calcutta metropolis had large area of marshy Salt Lake. With city's gradient towards the east Calcutta's open drain system was connected with this and water was pumped into Bidyadhari river for outflow into Bay of Bengal. But gradually the river became silted and a new canal was cut.

The improvement of drainage in the east was being discussed since the British established Calcutta at the end of the 17th Century, mainly to prevent malaria and cholera. In 1803 Lord Wellesley examined this and a British Engineer suggested outfall pump construction in 1856. In one hundred years about 150 million gallons of sewage was pumped into the river. In 1930 an Indian Engineer suggested abandoning Bidyadhari and construction of a new canal. In the same year first sewage fed fishery was experimented with recycling of waste water in indigenous process.

After partition of India in 1947, most of waterbodies went to East Pakistan (Now Bangladesh) and many fishermen migrated to India, many settled near Calcutta and wanted to develop sewage-waste water fed fisheries. The Government wanted to reclaim part of Salt Lake for city expansion, for drainage improvement and for health reasons. But despite this fisheries produced fish, employed people and provided better environment.

3. Science & Technology aspects

The indigenous system consists of several ponds. The waste or sewage waste water is taken into lagoon type pond with shallow depth for exposure to sun and photosynthesis process. The phytoplankton plant based micro organism is responsible for fish food chain. Waterhyacinth or duckweed is added to collect dirt. The wetland area is fitted with sluice boxes for periodical exchange of sewage feed. In Calcutta aquaculture is connected with natural compost based vegetable production where wastewater and sludge are used. The rich nutrient in waste water promotes quick growth. The indigenous technology is being adopted for aquaculture and urban food production with partnership of municipality, fisherman's co-operative and the owners. Many cities in India and other Asian countries are adopting this type of aquaculture.

201. Navuth Chay, Cambodia/Japan

Traditional Water Usage in Central Part of Cambodia: The Case of Sambo Village Kampong Thom Province Changing Concepts of the Hydrologic Circle

1- Introduction

This presentation is a part of my master thesis titling "Society and Culture in a Village of Central Cambodia- a seek for sustainable agricultural development". In this presentation I am going to introduce the Traditional water usage in central part of Cambodia the case of Sambo village Kampong Thom Province. The reason that leads me to choose this village as my study area because the area just located next to the Sambo Prey Kuk monument (a pre-angkorian monument and well known as the city of 7 century). Recently Sambo Prey Kuh is the target of the tourism industry. While the war ravaged the rest of the nation, the areas lay untouched: the region is now the largest, most pristine in Cambodia if comparing with other areas in Cambodia. Both local and national authority of Cambodia is seeking the ways to attract the tourist into this area, evidently the reconstruction of high way, and the agreement of renting this site to a famous local company SOKIMEX (as Angkor area) to be invested. Different from the Angkor region, the Sambo Prey Kuk region is a freshly and newly region with less or very rare, if one want to understand and develop this area. The purpose of the study is to record and understand the traditional water usage which been used by the villager in this region and making a readily suited recommendation for the further development planning. As the method of the study, I will use an intensive participation investigation, observation and randomly interview some key person such as the monks, ACHAR and people in the Sambo village.

2- Overview of present situation of Sambo village

Sambo village is one of the old villages located 35 km from Kampong Thom town and just approximately 100 meters from Sambo Prey Kuk monuments. In the south of this village there is a longest river in Cambodia "Stoeung Sen". Today the village becomes one of the must rapidly change village in the region. This village lives 1002 villager, the average number of member in a family 5 persons. The main income for their living is agriculture: transplanting is the primary type of rice cultivation, direct planting (shifting agriculture) is the secondary type and I can say this second type can be served as a security type of food production. Broadcasting is the last rice cultivation mode.

3- Traditional water use

There is several old water bodies can be seen from the aerial photo including pond, lake, canal. In the north of the village located an old water tank which still people use it as a daily water supply during dry season. In the far south lay a river "Stoeung Sen" which is flow from the mountain in the north of Cambodia. Recent year, a NGO initiated to dig a water tank in the south North of village.

In the south of the village located another 3 ponds. 1 of these three still function as a reserving water body for rice planting if the dam which was built long time ago and has been repaired several times during Khmer rouge and in the recent year by a NGOS. Another one far south west of the village, nowadays the people change it into the rice field during the dry season. But most part of the land surrounding this pond is occupied by the people from another village.

In general, no any scientific standard of irrigation systems can be seen in the area, but several local irrigation systems can be seen in the field. Those systems are the cutting passes water flow, which always can be found in the north (serve as an inflow passage) and south (serve as an outflow passage) of each rice fields. During the rice-planting season (raining season) the ox-cart tract have another function: main water flow, so this tract has a dual functions, transportation and main water distribution canal.

There is no existing of water user group or water management law. There no any institutions nor NGOs nor project nor development agencies advices the farmer. But the farmers have a mutual agreement in water management for their rice field.

4- Analysis and discussion

The water usage in Sambo village can be represented as a model, which initiated by the people and very efficiency model for farmer in this region but not in other part of Cambodia where there is different condition of ecological systems. While at the present most of the agriculture development strategy are set their method for increasing the rice yield by recommending the farmer to widen their rice field by making the rice field into a larger rectangular form and leveling the rice field as flat as possible, but here the rice field of Sambo village is a case of exceptions, making easier for water management.

Conclusion:

The traditional mutual water usage plays a vital role in the livelihood of the Sambo village. This type of water management must be maintained and improved to meet the future grow of population and the threat of the wave of "modernization".

086. James Dooge, Ireland

Changing Concepts of the Hydrologic Circle

Since water is so important for human life and development, it is not surprising that speculation about the natural processes of rainfall and streamflow dates back to the earliest times. It is interesting and instructive to trace the gradual evolution of the concepts that underlie the theory of the natural occurrence and movement of water on this planet.

In the ancient world, there were a number of different cosmologies but a common factor in all of them was the notion of a primal ocean. A number of examples of early developments of thinking are given. It is possible to reconstruct the cosmology of the Book of Genesis, to trace the development of hydrologic concepts in Greece from Homer (c 1000 B.C.) to Anaxagoras (c. 460 B.C.), and to identify similar concepts in China in the work of Chi Ni Tzu (c. 320 B.C.) and Lu Shih Ch'un Ch'iu (c. 240 B.C.)

In the later classical period and in medieval and renaissance times, there was no substantial advance in any of the basic concepts of the hydrological cycle. There was general agreement with the ancient viewpoint that the amount of rainfall was not sufficient to maintain the observed flow of springs and streams. The main discussion over these 2,000 years was on the mechanism whereby water from the oceans penetrated below the continents and was raised vertically through the continental land masses to emerge as springs on higher ground.

In 1674, Pierre Perrault, a retired Receiver of Taxes, published a comparison of estimates of rainfall and streamflow in a small catchment (6 square leagues) at the source of the River Seine near Dijon. Within a few years, Edmonde Mariotte, physician and plant physiologist, published a more scientific comparison of rainfall and runoff on the Seine at Paris where the catchment was much larger at 3,000 square leagues. A few years later, Edmond Halley the astronomer, compared estimates of both the inflow to the Mediterranean and the evaporation from it, concluding that rains were not sufficient to supply the full flow from springs. This division of opinion persisted throughout the 18th century and was only slowly resolved in the 19th century.

In 1802, John Dalton the pioneer of atomic chemistry, published a regional water balance for England and Wales in which both rainfall and evaporation were measured instrumentally and the total streamflow was calculated by scaling up from an estimate of the flow of the Thames. His conclusion was that "the rain and dew of this country are equivalent to the quantity of water carried off by evaporation and by the rivers."

In the 19th Century, the main progress was in the improvement in the techniques of measuring the individual processes involved (precipitation, evaporation, streamflow) and in the establishment of systematic long-term data-gathering systems. In the 20th Century, further progress was made in the understanding of the processes of infiltration and sub-surface flow and in the analysis of time-variation in streamflow and the occurrence of extreme values.

203. Hedi Daghari, Tunisia

Old Water Harvesting Techniques in Tunisia

In arid and semi-arid regions the rainfall regimes are characterized by a very strong irregularity. The annual mean can be recorded in a single rainfall. Large floods are often observed and flood water can be stored for later use or right away to irrigate by spreading over the neighboring areas.

In northern Africa collecting and storing rain water have been practiced for centuries and improved during the Arabic conquest (El Amami, 1984; Ennabli, 1993). Thus the technique of rain water collecting is an ancient art. The many structures of water collection, storage and transfer between regions spread all over the country prove the ability of the natives to manage the water deficit and the unpredictable climate changes (Daghari et al., 1989)

179. Walter Dragoni, C. Evangelisti, R. Burzigotti & L. Gervasi, Italy

The Role of Lake Trasimeno (Central Italy) in the History of Hydrology and Water Management

Lake Trasimeno is located in Central Italy, in an area where water management begun a few centuries BC. The paper outlines the hydrological history of the lake during the last millennia, and describes the various attempts by man to control the lake's water level. Lake Trasimeno is a closed lake, with no natural outlets; at present it has an average surface area of about 122 km², and a maximum depth of less than 6 meters. The lake level varies considerably, and is strictly linked to meteorological and climatic conditions. The Etruscans or the Romans probably dug an underground outlet in order to control the water level, but the date and exact location of any such construction is unknown. During the Warm Medieval Period (roughly between 1000 and 1300 AD) the water level was rather low, but it rose again during the Little Ice Age (beginning around 1400 AD), and the lake flooded large areas used for agriculture.

In order to control the high water a new outlet tunnel was built in about 1420, and in around 1480 the basin of the lake was reduced by diverting two streams towards the nearby Val di Chiana swamps. These works did not succeed in controlling the floods, and thus at the end of the 19th century a modern and efficient outlet tunnel was built. For this reason, the lake level is at least 2.5 meters lower today than the average level for the last four to five centuries. At present the climate in central Italy is changing again, with a decrease in the average rainfall and a slight increase in the average yearly temperature. Over the last sixty years this trend has caused a substantial lowering of the lake water level, which creates serious problems for the lake ecosystem and economy. In order to stabilize the level of the lake, in 1962 the streams diverted in 1480 were linked again to the lake, but the results have not been satisfactory: once again, as in the past, new actions are planned to cope with the new situation. The long history of the water management, projects and hydraulic works in the Trasimeno area has had

a significant influence on the history of hydrology and hydraulics. Indeed, just as modern water science was being born, the problem of Lake Trasimeno initiated a centuries-long debate over the choice of the best actions to be carried out: for example, in about 1639 the hydrologist Benedetto Castelli gave the first description of a rain gauge in Europe while he was involved in the Trasimeno Lake problem.

148. Anne Dubois & Thierry Ruf, France

Ansignan, A Pyrenean valley with many hydraulic historical enigmas

The bridge aqueduct of Ansignan, situated in the high valley of Agly (Oriental Pyrenees, France) irrigate since more than a millennium the low lands of the village, today recomposed in domestic gardens. The canal going on the aqueduct (which is locally considered as roman) is now managed by a Property owners' syndicate created in the end of the XIXth century and still active nowadays.

The surprising longevity of this building in the time aroused a territorial study with a socio-historic approach of water resource's management and an analysis of the emergent conflicts over the last two centuries.

Two main elements are already identified: On one hand, two poles of strong solidarity (water resource's sharing, presence of canals on several municipal areas...) appear on both sides of an ancient historic border separating the Kingdom of France (corresponding to the high valley) from the Kingdom of Aragon (corresponding to the plain) created by the Corbeil's treaty in 1258.

On the other hand, those two poles, set by the history and subjected to different juridico-institutional regimes, were opposite by recurrent conflicts about resource's sharing: Whether each irrigators' community claims the age-old rights granted on waters, or whether this community notices an inequitable water's distribution in the valley (the presence of one karstic system entails the following situation: whereas the high valley always enjoyed plentiful waters, the plain suffers systematically from severe scarcities in period of low-water mark).

We formulate the followed hypothesis : water's sharing in this valley often provokes conflicts but those ones stimulate the assertion of the rights of each and motivate the protection of the hydraulic patrimony during several centuries until nowadays.

055. Mohammed el Faiz, Morocco

The Contribution of the Arab Engineers to the Development of Hydraulics (Xth century to XVIth century)

Can we praise the millenary hydraulics without taking into consideration the diversity of the sources that have implemented its history ?

In considering this issue, the aim of this paper is to try to study the contribution of the Arab engineers to the history of hydraulics from Xth century to XVI th century. After analysing the relationship between the Islamic society and water, the author examines the definition of the hydraulic domain in relation to the emergence of hydraulic engineers and the contents of their writings. It closes up in giving some solutions to the distribution of water in the cities of the Arabic World.

In French:

Parmi la masse des écrits consacrés à l'histoire des sciences et des techniques durant l'Antiquité et le Moyen-Age, la part réservée à l'évolution de la science hydraulique reste, malgré les efforts accomplis, très limitée, voire marginale. On compte actuellement quelques titres seulement en français et en anglais, abordant des thèmes qui relèvent spécifiquement de l'histoire de l'hydraulique. Cependant, ce qui semble commun à la plupart de ces écrits sur le plan méthodologique, c'est l'importance accordée aux réalisations de la civilisation gréco-romaine et la négligence des apports des aires géographiques et culturelles non occidentales. Nombreux sont les historiens qui continuent à considérer qu'entre la chute de l'Empire romain (Vème siècle) et le début de la Renaissance (XVIème siècle), rien d'important ne s'est produit dans le domaine de l'hydraulique.

Dans ce contexte, un des intérêts de notre communication, c'est de montrer que l'avènement de la science grecque fut précédé par plusieurs siècles d'évolution de l'hydraulique proche-orientale (Egypte,

Mésopotamie, Syrie...) et d'intégrer l'apport du Monde arabo-musulman au développement de la science des eaux au Moyen-Age et au début de la Renaissance. Ce changement d'attitude nous paraît essentiel. Il nous incite, en tout cas, à analyser et à faire connaître l'apport des mécaniciens arabes à l'histoire de l'hydraulique. Nous examinerons tour à tour le rapport entre la formation de l'Empire de l'Islam et la question de l'eau (I), l'émergence de l'hydraulique en tant que champs disciplinaire(II) , les figures et les œuvres de l'hydraulique arabo-musulmane (III) et, dans un dernier point, quelques cas de solutions mathématiques originales apportées au problème de la distribution de l'eau dans les villes arabes (IV).

003. Nouredine Gaaloul, Tunisia

Water Resources Management in the History of Tunisia

The hydraulic history dates back to the first installations which were intended to control the rise and fall of water foreseeable in time, but unforeseeable in its flow: where the older people had built a series of water collecting areas. The inhabitants were constrained to deploy a real know-how as regards water control, especially to manage so random water resources, to be able to live in a difficult though natural environment in a country like Tunisia.

The various hydraulics installations through the history be the old men by stopping with water stone using Roman knowledge (case in the oasis of Gabes) and a system of harvesting rainwater in Kairouan, finally realigning an urban like construction of the aqueduct of Carthage connected to the source of Zaghuan, the old sanctuary of water, by building a work of more of 70 km, towards 130 thus as per the policy of Antonio.

In an arid area, where agriculture is often random, but which also possesses a potential of an astonishing diversity plains, sahels, valleys; and oases which are the ecosystems where the problems of the intensification and irrigation can be seen in particular.

In the south of Tunisia, the inhabitants built a fortress (ksar) at the most inaccessible site in the area, and used it to store the local population's food reserves (e.g. oil, barley, wheat, dried figs and dates). The fortress was protected by outlying posts and an alarm system. At the same time, the town's residents developed water harvesting techniques (earthen dikes or jessour, and cisterns) for the mobilization and use of rainfall and runoff waters. These water harvesting systems are still in use today. The jessour, built in the intermountain runoff courses, capture water and silt and create terraces where fruit trees (e.g. olive, fig and date palm) and annual crops (e.g. cereals and legumes) are cultivated. The cisterns, locally known as majen or fasquia, are small to medium (1 to 50 m³) subsurface reservoirs where rainfall and runoff are stored for domestic uses, livestock watering and occasional supplemental irrigation.

129. Kaushik Gosh, India

Overflow Drainage Basin Management in Bengal: A Historical Perspective

Water resource management and irrigation has been the oldest applied sciences in the world whose centers were the oldest civilizations. Healthy irrigation itself was a great school of civilization where men worked together in harmony breeding health. Some 6000 years ago the Egyptians introduced their system of basin irrigation into the Nile Valley by digging canals which in use today, and leading the turbid waters of the Nile into the embanked basins. Contemporaneously with them, the Babylonians began their system of perennial irrigation in the joint delta of the Euphrates and Tigris.

The system of drainage basin management by overflow irrigation was evolved by the rulers of ancient Bengal some 3,000 years ago. West Bengal is a small state in Eastern India; its landscape crisscrossed by innumerable streams and rivers. It enjoys a maximum rainfall of from 50 to 60 inches. However, Bengal often suffered from the vagaries of nature like devastating floods and droughts. Instead of trying to master nature, the ancients chose to adjust their ways to the physical environment. These methods are the accumulated wisdom of a predominantly agricultural community whose farming practices were very simple and technological application was optimal.

Full use was made of the:

- Rich waters of the Ganges river and Damodar river floods, and
- The abundant of the monsoon rainfall.

Drainage basin management was done by digging canals which controlled the basin overflow and ensuring regular water flow to the fields. Overflow canals of Bengal worked under different conditions. Irrigation of the country was principally done by rainfall and the river water was used to manure the rainfall, and kill the mosquitoes or deprive them of their malignity.

The role of the farmer was simplified to cultivating the suitable crops at the right time. Their cropping pattern, like the cultivation of rabi or kharif crops was also developed keeping the variation in seasonal availability of water in view. Plots of land were classified according to their ability to retain moisture or accessibility to water. A little ingenuity was enough to meet their needs of irrigation in times of relative scarcity or to irrigate lands which were away from rivers. It was what today's experts call water harvesting by ponding.

The ancients by increasing the supplies of muddy water, steadily improved the lands as time went on, and also decreased the danger of an inundation. The minimum supply for healthy rice irrigation is one cubic foot per second for 70 acres. Any extra water above this, as time goes on, is an improvement.

Drainage basin management through overflow canals irrigated an area of almost 7,000,000 acres in Bengal. After seeing the results of seventy years of abandonment it is quite imperative that there is nothing before the country but to return to it.

This method of overflow drainage basin management is not only adapted to Bengal but to all countries similarly conditioned.

005. Heather Hoag, USA

Enter the Engineers, Surveyors, and Other Experts: The Rufiji Basin Survey, 1952–1961

The desire to utilize the Rufiji River of Tanzania for economic development led to a continuous attempt on the part of both the colonial administration and independent Tanzanian state to control and manage the Rufiji waterscape and its residents. Between 1945 and 1985, development projects formed a nexus where competing environmental and development ideologies were expressed and shaped by local realities. Influenced by international experiences, in the 1950s colonial planners shifted their attention away from mechanization (the previous focus of their development efforts) toward irrigation and more encompassing, basin-wide river planning. Coupled with this policy shift was the need for greater understanding of the hydrological and environmental processes of Tanganyika's river basins. In 1952, the Governor of Tanganyika, Sir Edward Twining, approached the F.A.O. with his need for studies of the territory's river basins, including the Rufiji Basin. After preliminary investigations in 1953 and 1954, the Tanganyikan government and F.A.O. signed in 1955 a formal agreement for a reconnaissance survey of the irrigation potential of the Rufiji Basin. However, by the conclusion of the Rufiji Basin Survey in 1961, the year of Tanganyika's independence, the emphasis had shifted from an analysis of irrigation capabilities to a plan for hydroelectric power generation, flood control, and irrigation by means of a series of dams throughout the basin. The report the F.A.O. team presented the new Tanganyikan government was an example of a template for basin development that had originated in the United States but was quickly becoming the global model for economic development.

This paper explores the process by which Western-trained planning officials and scientists began translating past understandings of the Rufiji environment into modern scientific prose. On the ideological level, Western, abstract paper-based forms of knowledge assumed privileged positions over local, quotidian understandings of the area's waterscape. Series of numbers quantifying stream-flow replaced stories of high floods and the famines that ensued, earlier examples of the relationship in people's memories between the river and society. Development scientists ignored local knowledge of the basins' microenvironments, knowledge held by residents and district-based colonial staff, in favor of numbers and US Bureau of Reclamation soil classification types. Where their predecessors tramped through the mud and floated down the region's rivers sketching what they saw, the FAO team was physically separated from the Rufiji ecology. The team viewed the Rufiji from Land Rovers and government airplanes, sending their data to colleagues in distant offices for analysis and abstraction into maps and graphs. The portrait that emerges is one dominated by faith in modern engineering science with little, if any, reference to independent environmental agency or Rufiji residents. This detached way in which the survey team interacted with the Rufiji waterscape resulted in the belief that the river could be controlled, a perception that inspired the hordes of development planners and engineers in later years to plan the

Stiegler's Gorge Dam. The Rufiji Basin becomes a laboratory within which outside planners and scientists can plan Tanzania's version of the Boulder Dam at Stiegler's Gorge.

122. Kim-Hyeonjun & Hong-Ilpyo, S. Korea

Records of the Ancient floods of the Korean Peninsula from the Annals of the Chosun Dynasty

Since 1990s, the Korean Peninsula faces frequent heavy rainfalls and typhoons with severe damage. A historical maximum, 2nd and 3rd damage by the floods were happened after 1990. In 2002 August, a heavy storm and typhoon "Rusa" caused tremendous damage more than 5 billion USD. From the historical documents, many ancient flood records were reviewed. A historical records of the Chosun Dynasty, the Annals of the Chosun Dynasty *), describes 470 times of flood related events for the periods of 1392-1910. According the Annals, the floods from the 1545 to 1674 happened more than half of the total floods for the 519 years. During the 132 years, flood happened especially frequently for the whole country.

There was a certain period which has a similar trend of flood situations of recent years in Korean Peninsula.

*) The original text of the Annals (Chosun Wangjo Silok) covers 27 kings from 1392 to 1910, containing almost all kinds of information including the innermost political situations as well as the everyday life styles of ordinary Koreans. The Chosun Wangjo Silok was listed on UNESCO's World Record Heritage in 1997.

120. Hong-Ilpyo & Kim-Hyeonjun, S. Korea

A History Typhons and Damage of the Korean Peninsula from the Annals of the Chosun Dynast

The August 31st in 2002, Korean peninsula had a tremendous typhoon "Rusa", which did a great deal of damage to the territory. Especially, 879 mm of the historical daily rainfall was recorded at the Kangneung area of the east coast. It was the maximum-recorded daily precipitation in Korea. Most of the rivers were devastaed and a large number of structures were destroyed, and a lot of urban and agriculture area were flooded. The typhoon "Rusa" with tremendous rainfall caused 246 deaths and 5,150 billion won (USD 4 billion) of property loss for the whole Korean peninsula.

In Korea, the history of modern meteorological observation is at least 100 years. The first observation station was installed in 1904. But in the Annals of the Chosun Dynasty *), called 'Chosun Wangjo Silok', detail informations about the typhoon and flood during the period of 1392-1910 were recorded, not the observation gaging data but the descriptions of damage and aspect.

According to the Annals, there were 177 times of typhoons and 62% of them came from June to September with heavy storm and wind. From the historical documents, the aspects of ancient natural disasters were able to analyzed. In 1605 fall, a severe typhoon like typhoon "Rusa" was happened in the east coast happened with great damage.

*) The original text of the Annals(Chosun Wangjo Silok) covers 27 kings from 1392 to 1910, containing almost all kinds of information including the innermost political situations as well as the everyday life styles of ordinary Koreans. The Chosun Wangjo Silok was listed on UNESCO's World Record Heritage in 1997.

172. Md. Rashedul Islam, Bangladesh

History of Water Laws to Resolve Conflicts on Transboundary Rivers and Future Directive

Transboundary rivers flow over several territories. Any regulation on such rivers has pronounced impact on the users of the downstream countries. As many rivers of the world are transboundary in nature, conflicts among nations are rising at an alarming rate. Over 3600 treaties can be identified on international water bodies in history. Recent trend has been observed to set laws on transboundary river regulation which supposed to be accepted by all countries. Prof Smith (1931) showed legal aspects on his book "The Economic Use of International Rivers". He emphasized the doctrine of riparian rights, which entitled the lower riparian states to a share of the natural flow of a river. Thereafter, Dubrovnik rules for international rivers came out in 1956 by the International Law Association (ILA). In 1966, the same authority proposed Helsinki Rules. The objective of the Helsinki rule was to introduce a drainage basin concept on water laws. But all countries of the world did not accept these rules. Later, International Law Commission (ILC) of the United Nations decided to begin with the formulation of general principles. In 1991, the ILC produced a draft report on the law of the non-navigational uses of international watercourses. In 1997, the UN General Assembly approved the resolution on non-navigational uses of international watercourses.

In spite of this convention water conflicts in many transboundary rivers (e.g. Mekong river, Ganges river etc) is noteworthy. A major problem of the proposed convention is that, in many cases it has no specific direction rather generalization is significant. In this study, it has been directed to develop a more specific set of rules gradually, which can be helpful in resolving water conflicts in future.

037. E.J. James, India

Traditional Sources for Meeting Water Demands: Case Study from Kerala- a Humid Tropical Region in India

The density of population in Kerala State, situated on the south-west coast of India, is very high with an average of 1000 persons/sq km. Kerala is in the humid tropics with an average annual rainfall of 3000 mm. However, the State faces shortage of fresh water during the summer months (February-May) due to the non-uniform distribution of rainfall and steep topography. The people of Kerala have been depending on their traditional water sources, for several centuries.

The State has the highest density of open wells in the region. Kerala with 38864 sq km area has 4.7 million open wells, about 120 wells per sq km. Of these, 3.8 million wells provide water round the year. These wells cater to the drinking water needs of 20 million, out of the total 30 million people of the State. The people of Kerala have invested Rs 45,000 million (US \$ 1000 million) on these wells.

The local people have perfected the art of locating these wells and their construction and maintenance. These wells are generally shallow, depth rarely exceeding 12m; the diameter varies from 2 to 5m. Most of these wells yield 1500 litre/day; a few of them yield as much as 20,000 litre/day. A laterite masonry work along the perimeter protects these wells; this masonry structure rests on a gooseberry timber block placed at the very bottom to avoid differential settlement and to help in purifying water. Some of these wells are constructed close to the house and are accessed through the window of the kitchen. When water is polluted, certain medicinal plants are used to purify it.

Not only in the rural areas but also in a city like Calicut, with a population of 0.4 million, 56 percent of people depend on open wells for their domestic water requirements. A few well-based self-help groups have initiated construction and maintenance of community wells. This participatory model is being followed by several of the local governments, now empowered by the new legislation.

Apart from the family-based open wells, the people of Kerala also depend on other location-specific traditional sources for meeting domestic water needs. The tribals and others in the highlands of Western Ghats depend on springs; those people living in the plains use the ponds and tanks; and those on the foothills of northern Kerala use the 'horizontal wells', locally known as surangams. Due to unscientific construction of bore wells, changes in vegetation pattern and reclamation of wetlands, some of the traditional sources are drying up in summer. During the years with less rainfall, 10 percent of wells dry up in summer, adversely affecting 2 million people. Faecal contamination has posed threats to these traditional sources. With all these limitations, detected recently, the schemes based on these traditional

sources have proved to be sustainable in comparison to the large-scale piped water supply schemes based on modern technology.

038. K. J. Joisea, India

The Role of Government in Water Sector in Ancient India as Revealed from Kautilya's Arthashastra

The Arthashastra is a treatise on statecraft, attributed to Kautilya (also known as Chanakya), the mentor of emperor Chandragupta Maurya of fourth century BC. He gave considerable importance to water management in his work, since irrigated agriculture was one of the main sources of revenue to the state. A critical study of the Arthashastra brings to light the water law, water pricing and responsibilities of the Irrigation Department prevailing at that time in India. The treatise also gives a vivid picture of the water management practices of ancient India. The Arthashastra in 15 books (adhikaranas) presents 6000 verses (slokas).

It is evident from this work that the people of ancient India have been familiar with the rainfall distribution, soil classification and appropriate irrigation practices for different agro-climatic zones. The earliest mention of a rain gauge (varshamapini) is found in this work. It gives the details and dimensions of the rain gauge and the locations where it has to be installed. The rainfall data for certain locations of the empire are furnished and depending on the rainfall, the empire is divided into the wetlands and dry lands. Certain principles have been prevalent at that time to classify the land according to land capability and land irrigability. Apart from the traditional sources, man-made structures like tanks, reservoirs and wells were used for irrigation.

The Arthashastra brings out certain salient features of the water law of the period. The upstream and downstream water rights were well defined. For example, a tank built downstream of an earlier existing tank should not flood the fields irrigated by the upper tank. A tank constructed upstream should not deprive the downstream users. The law stipulates not only fines but also emptying of tanks for cases of violation. Exemption from tax was given to those involved in the construction and renovation of irrigation works. Fines were imposed on those who let out water from dams out of turn, and on those who obstructed the water allocated to others. Fine was also imposed on those who obstructed a customary water course.

The responsibilities of the Head of Irrigation Department, according to the Arthashastra, included construction of irrigation systems and aiding others involved in these activities. In waterless regions, the government superintendents were in charge of constructing wells and other water works.

The Arthashastra clearly talks about a water cess over and above the normal land revenue levied by the state on users of irrigation facilities. Even those using their own private waterworks had to pay some cess. The ownership of fish, ducks and green vegetables in the irrigation works should go to the king. It is interesting to note that the ancient Indians had practised scientific water management. Their concepts pertaining to water law and pricing have relevance even in the modern times.

065. Shahram Karimi, Iran

"QANAT" as The Symbol of The Native Iranians In Water Harvesting From Ground Water Resources

Iranians have been superior in supplying and controlling water through the history of man. Dams, irrigation networks, bridges, weirs and the other similar water structures which have been stand-still and many of them have been under operation since thousands years ago.

The geographical situation of Iran shows almost of the areas are dry and desert, the hardship of living in these areas caused the local people to innovate Qanats as the water supply resources by their native knowledge. In Qanat system, the Iranian well diggers, excavate some wells and connecting them at the

bottom by a tunnel with a moderate slope less than surface gradient and the existing water in the aquifer was collected and led to the lower areas by the gravity system.

The existence of more than 40000 Qanats with the age of almost 6000 years in Iran where 30000 of them are under operation now which show the ability of native Iranians in water harvesting in these regions where the precipitation is very limited and there are not any runoff.

The present paper introduces this native Iranian technology and defines Qanat, its history in Iran and the world, the architectural characteristics and Qanat excavation structure, the required condition for Qanat excavation, the method of excavation and their types are some of the objectives which will be discussed

At the end the Iran well known Qanat concerning the age, length, depth of main well and also the special Qanats in desert where the under ground dams were established over them are brought up in brief.

015. Mina Kleich-Dray, Morocco

Origin of the development concept "Agronomists' rôle in the transplantation of irrigation techniques during French protectorate" (1928-1945).

My contribution to this symposium aims at showing the role that agronomists have been playing in the land production reform from the French protectorate period onwards. As a matter of fact, the success that irrigated agriculture has met in the USA accounts for the attempt of agricultural engineers to develop similar means of production in Morocco, through the use of more sophisticated farm implements. This technical choice is undoubtedly on the model of the one which emerged during the French Protectorate and irrigated agriculture is still appealing to the Moroccan agronomists today as a way to get into the industrial process that goes along with modernization. My speech today is meant to analyze the role of this new social group which were the agronomists in the Morocco of the 1930's. Indeed, they were the first actors of the agricultural development in Morocco. Originally, the French agronomists were sent over to Morocco to transform the Moroccan countryside so as to make of the country a foodstuffs reserve for a developing French food industry.

Until the financial crisis of the thirties, the role of the French agronomists consisted in selecting and distributing wheat seeds to the settlers thus checking the output which had been previously imposed by the French Administration but the crisis showed how limited their policy was. Therefore, the agronomists were asked to set up "grands ensembles d'agriculture industrielle" with large irrigated areas in order to enable financial trusts to invest in the production of exportable foodstuffs such as citrus...(following the example of the Californian agriculture model at the same period.) Irrigation was then seen as the ideal way of turning the unsophisticated farming methods into a modern, industrial agriculture. Hence, the development of the citrus production allowed the launching of the colonial hydraulic policy, the agronomists who were then obsessed by technology which they thought could guarantee an increase in the farming production, were also persuaded that the use of these new techniques was synonym of social neutrality. At that point, we can say that science will make agriculture enter the modern world.

Through the example of the irrigated area of Tadla carried out at the end of the thirties, I suggest to study this traditional pattern which was developing at the time. Indeed, after the opening of the KASBA TADLA derivation dam in 1928 along with the BIN EL OUIDANE storage dam in 1953, the agronomists imposed on the population of Beni-Amir and Beni-Moussa, a strict regrouping of lands and discipline as far as water supplies, field works and crops were concerned. To get water, the fellahs had to subscribe to a contract which did not let them the freedom to choose their crops or even the carrying-out of their farming production. In such a "bureaucratie centralisée" the fellah is kept in the background and the muhandiz appeared as being a new social group in charge of development.

020. Gert Knutsson, Sweden

Springs as Indicators of Past and Present Environmental Changes

The conditions in and around a spring give an integrated, condensed representation of the biological, chemical and physical processes in its catchment and indicates thereby the changes in the environment of the catchment at one single site. Otherwise such information has to be gathered from many different

spots in soil and water. Furthermore, springs are very suitable for these type of studies, as good water samples can easily be taken without disturbances by pumping as when taking samples in tubes and wells.

The conditions and changes in the past are documented in minerogenic sediments of the spring, e.g. siderite and travertine or in organic deposits as peat downstreams the spring. Changes in climate, e.g. higher precipitation and temperature with more intense weathering and leakage have resulted in increased sedimentation of bog iron ore in acid environments or of travertine in basic environments. Fossils are very well preserved in travertine. The postglacial changes in climate and the development of the vegetation were discovered in the travertine of springs in southernmost Sweden before the pollen analysis was introduced. Some archaeological objects have been preserved in "spring peat", for example a pile-work in wood from the Stone-Age in Sweden.

Present changes in the catchment of a spring can directly be detected by regular analysis of the water chemistry and measuring of the runoff from the spring. Quantitative impact in form of drainage or pumping somewhere in the catchment will result in lower runoff from the spring or lowering of the hydraulic pressure; even removal of the outlet of the spring. Qualitative impact of the environment as pollution at one spot or diffuse pollution of the whole area will be registered in the chemistry of the spring water and in the changes of biota. Acidification of soil and groundwater due to acid precipitation has been documented by time series of pH and alkalinity in some springs in the Nordic countries, even so called acid surges in small springs, which damaged the biota. Pollution from agriculture (before all nitrate) or from roads and traffic (for example chloride from de-icing salt) are detected in many springs.

057. Miomir Komatina & Snezana Komatina-Petrovic

History of Hydrogeology in Yugoslavia

Yugoslav hydrogeology joined courses of the world science and practice very early, giving strong geological base to the new discipline. It is noticeable that famous Yugoslav geologists marked the last decade of the 19th century by numerous papers referring to groundwater, among them, by capital contribution of Svetolik Radovanovic "Ground waters – aquifers, wells, thermal springs and mineral waters" (1897). In that period, until the beginning of the 1st World War, special attention was directed to mineral waters of various localities, their genesis, quantity and chemical content, but significant results were also obtained within exploration of ground water sources for water supply of greater settlements. So, even in 1884, investigation of the Sava alluvial plain (Makis locality) began, while in 1892, Beograd was provided by the first source and modern water supply system. However, the most important contribution was made in the field of exploration in karst terrains, unique geological phenomenon and significant water-bearing medium. The greatest merit belongs to Jovan Cvijic (1893, 1900, 1918). The mentioned topic was also developed in the period between the 1st and the 2nd World War (particularly from 1930, when a national Geological Institute, later Geozavod, was founded).

Period after the 2nd World War presents an occasion of sudden popularization of hydrogeological staff, characterized by, first of all, for sixties, from when at the Faculty of Mining and Geology in Beograd, a separate Department of Hydrogeology exists. Till the end of 1975, the whole territory of the country was covered by regional hydrogeological exploration, while detailed survey in the areas of water supply, mining hydrogeology, and use of carbon-acid and thermal waters, constructing hydrotechnical structures in karst and so on were carried on numerous localities of interest. Successful solutions of different problems in karst in the country and abroad, in the field of planning surface reservoirs and discovering ground water sources, made by Yugoslav experts, are certainly well known.

100. Matti Kummi, Finland, Damian Evans & Roland Fletcher, Australia

The Dynamics of Water Management of Angkor, Cambodia, 9th to 16th Century

The World Heritage site of Angkor, in Cambodia, is famous for its monumental religious constructions, which have been studied in great detail over the last century. Recent research has uncovered an equally impressive feature of this medieval capital: an extensive hydrological network stretching across a thousand square kilometers. Although Angkor's hydrology is not nearly as well understood as its religious architecture, it seems as though this system may have played a key role in the city operation and may also have played a role in the demise of this urban complex in the middle of the second millennium CE.

Airborne synthetic aperture radar (AIRSAR-TOPSAR) data have been used to create a GIS database of the network of canals, reservoirs and embankments used to manage water in Angkorean times. Very often these features have little or no surface manifestations, but are clearly visible in the radar data due to subtle differences in surface vegetation and electrical properties. The TOPSAR elevation model is critical for understanding the dynamics of the fluvial environment. The data have proven particularly useful in the discovery and analysis of Angkorean hydrology.

The Greater Angkor area can be divided to three hydrological zones: upper, middle and lower. In the upper zone the water was taken from the natural rivers running from the Kulen Mountains and spread to the North-South aligned channels. In the middle zone the water was collected in big barays, water reservoirs, and temple moats for multifunctional purposes. The lower zone operated like a drainage system for the temple area and disspread water down in the Tonle Sap Lake.

Using the GIS database, TOPSAR elevation model and powerful hydraulics and hydrological models it is possible to investigate how the hydrological network was developed, how it worked and why and when it collapsed. Understanding the water management of the Angkor area will help us to better understand how the urban complex operated and may offer new information about the decline of Angkor.

102. Tarik Kupusovic & Dalila Jabucar, Bosnia and Herzegovina

Sarajevo's Water Supply System – Through City Development

The first water supply network in Sarajevo was built back in 1461. During the Ottoman period, Sarajevo had 68 water supply networks lengths from 1 meter to 8 km. At that time, Sarajevo was well known after numerous drinking fountains, more than 160 of them. Austria-Hungary Empire built the first modern water network- Moscanica, with capacity of 80 liters per second. Number of inhabitants in Sarajevo in this period was approximately 21400.

With town development, the needs for drinking water were increasing. From 1951-1981, was built contemporary water supply system with well field, number of pump stations, reservoirs, etc. Eighties passed without water supply reduction, and Sarajevo increased number of inhabitants on approximately 250000.

Ten years later, town government challenged water supply shortage again. Long-terms plan for water supply in Sarajevo included design of water storage Bijela Rijeka, with main purpose of discharge balances and for water intake. This was very complicated solution with large initial investments.

Since there were delays in realization of this solution, in 1992 was adopted the new plan, that should provide recharge of Sarajevo's natural underground water storage from water streams Zeljeznica and Bosna. That new system named "Crna Rijeka" consists of Crna Rijeka water storage, aquaterrain Sokolovici, infiltration lagoon, drainage collector and regulation of river Zeljeznica. The advantages of such system would be: improvement of water regime of river Zeljeznica, especially during the summer, good flood protection, use of hydropower, development of water tourisms, and phase building. New system was planed to meat the needs of Sarajevo up to year 2032.

142. Simo Laakkonen & Sari Laurila, Finland

A river divided? Science and media.

Most people acknowledge the role of science in defining environmental problems. On the other hand the role of media is important in addressing environmental problems for politicians and the great public. There seems to exist a natural link between these two spheres of society. In reality these two elements phenomenons seem, however, to be rather distant from each other, if not apart. The paper aims to study how scientists and their work on water problems were considered by media. The study will focus on the Baltic Sea region and cover the 20th century.

Simo Laakkonen has PhD in environmental history. He works currently as a senior lecturer of environmental politics at the University of Helsinki. he has published several books and articles on environmental history. His work focuses on the history of environmental mediation.

MSc Sari Laurila is a hydrobiologist from the University of Helsinki. She has studied the history of scientific studies on water problems in Helsinki and in the Northern Baltic Sea region. She works currently as a researcher in a project supervised by Simo Laakkonen on the environmental history of the Baltic Sea funded by the Academy of Finland.

Results of this and previous projects may be seen in the following address:
www.valt.helsinki.fi/projects/enviro

094. Erik Lövgren, Sweden

The Construction and Use of Levadas in Madeira, Portugal, between 1461 and 2002

The levadas is the name of an extraordinary aqueduct system for water distribution on the island of Madeira, Portugal. The Levada system includes more than 1000 km of built aqueducts all around the island. Compared to modern channel work there is one specific characteristic which is the narrow and deep cross section of the aqueducts. Originally built for irrigation purposes the aqueducts are now also used to feed hydropower plants and have been most important for the electricity supply of Madeira.

The historical beginning of the Levada construction work is documented as far back as 1461 and was a technological solution to meet the demand for irrigation water, on the south side of the island. The need to transport water from the mountain range where precipitation was high, to the farmland in the south where water was scarce, became strong. The soil constitution in the northern rocky parts of Madeira was also bad, and good farmland was inaccessible because of the steep cliffs in the north. The south ravine sides had rich and fertile soil. Farming would be much more efficient if the mountain water could be transported to the south side of the island instead of being drained out into the ocean on the north side.

Another use of the Levada network is for transportation. The sometimes roofed Levada channel and the narrow path beside it is used for access in the daily work and for distribution of crops to the markets, but also for building and maintenance of the Levadas. That was a very important use in an environment where roads were labor intensive to build and maintain because of the extensive steep ravines that covered the whole island. In the lower parts of Madeira these paths later became roads for transportation but higher up in the mountains a small path where two people could barely meet is still used for transportation.

A conclusion of this investigation is that the Levada channel network system is an historical monument of an agriculture based system. An old culture demanded hydraulic engineering technology for survival in an arid mountain range that has in recent times been most useful for the development of the power supply and tourism in Madeira's modern culture. The electrification system benefits from the flowing water in a new conceptual way. A hypothesis is that the aqueduct system for distribution of a small water flow between the mountain range and the reservoirs downstream would not have been built for the water supply in a modern centralized hydropower system because of the expense. A village based agriculture system could build and maintain this channel system for the benefits of a more modern society with other demands. Many old hydraulic engineering projects may find a modern use after rethinking demands. This paper will also analyse the development of water management rules and regulations from 1461 to our days, as the demands changed and developed due to changing culture values.

093. Sylvia S.Løvgren

Economical Prosperity of Waterfront Societies - The Trade of Dyestuffs and the Necessity of Water in the Dyeing Process.

History has shown that colour has been important to man for thousands of years. We know of the cave paintings of Altamira and the caves in France where artists of the past left huge paintings. People of the stone age used red, and sometimes yellow ochre at burials. The pigment was of such importance that they sometimes traveled hundreds of kilometres to get it. Body painting and tattoos were also common. By and by the dependence of water became a necessity for large scale production in the prehistoric days of dyeing production.

Pigments, dyes and dyestuffs became more and more important both to the world of the living and to the dead. They were sometimes hard to come by and thus very expensive which made them inaccessible to

the common man. Certain pigments like Lapis Lazuli were as expensive as gold. Lightfast dyestuffs were also sought after and highly priced. Indigo and Tyrian purple are examples of such dyestuffs.

The manufacture of Indigo is at least 5000 years old as dyeing vats have been found in the Harappan city Mohenjo Daro on the banks of the Indus river in Pakistan. In the centuries to come loads of indigo was brought to the ancient civilizations of Mesopotamia among the Sumerians, the Babylonians and the Assyrians. The Egyptians also used indigo to dye linen as has been shown in preserved textiles from the 16th century BC.

The dyeing technique of the plant *Indigofera tinctoria* is an early form of applied biotechnology which was one of the earliest cultural assets of mankind. Water was a necessity for the process. Indeed some of the manufacturing societies would not have prospered economically the way they did, had this not been a fact.

The aim of this paper is to show how important water was to early forms of technical innovation by the example of dyestuffs, specially indigo since this is one of the very few dyestuffs that is still widely used today.

041. Iik Arifin Mansurnoor, Brunei Darussalam

Perceiving Water as the Given and as an Agenda: Brunei Water Village in the Past Hundred Years

My paper will address the crucial role of water in the development of state and society in Brunei. As is widely known, the original settlement in Brunei and its later development into the political and economic center is known as the Water Village. Indeed this settlement "swims on water" until today. Ironically, despite the commonality and ubiquity of water, the inhabitants of the settlement, before the foundation of pipe water, had problem of gaining access to fresh water. It will be interesting to examine how people develop the means and strategy to survive in a place full of water. Even the history of water in the second half of 20th century Brunei continues to be complex and interesting.

Attempts at "dewaterization" of Brunei took place in many stages and for diverse reasons. In the beginning of the century, when Brunei was under the British residency system, a decision was made to re-settle the population of the Water Village into newly reclaimed land-based villages. The reason given at the time was feasible enough, Water Village was environmentally polluting and from hygienic perspective unhealthy. Very little progress was made on this initiative, except the shopping facilities and administrative offices across the water village on land, which has developed into the present down-town area of the Brunei capital. Next, after the WW II, concomitant with restoration and modernization of the country, more serious and well-planned re-settlement programs were announced. Participants were provided with housing, funding and agricultural land. Some progress was made as some villagers in the Water Village at least registered their name for the resettlement program. By the last decade of the 20th century, with full government support and multi-faceted change in the country and the more mobile inhabitants of the Water Village, resettlement program has won the heart of most villagers.

My last part of the papers addresses the attempts of various administrations to provide fresh, clean water to the citizens. This ranges from taking advantage of small water springs in many different locations to building major water reservoirs. Under all these attempts, water at the Water Village played insignificant role other than its traditional role as "road and garbage dump." More significantly, the water engineering in Brunei has become the affairs of the policy makers and has little to do with the inhabitants of the Water Village. The latter emerge merely as object and later benefactors of modern water facilities. The issue remains, what will be the future of this unique water settlement? Should it be gradually ended as the trend is taking place now? Or should it be maintained and modernized in the hope of becoming a tourist attraction, reviving the old saying that the Brunei Water Village is a reminiscent of Venice?

080. D.L.O. Mendis, Sri Lanka

The Ancient Water Heritage of Sri Lanka

Sri Lanka is an island in the humid tropics near the southern tip of India, with a bi-modal rainfall pattern called monsoon rains. The ancient water and soil conservation ecosystems of Sri Lanka are better known

as ancient irrigation systems (Brohier, 1934; Arumugam, 1969). Irrigation is only one of their functions, although arguably the most important one. Other functions include flood control, drainage, soil conservation, and conservation of fauna and flora after the introduction of Buddhism in the 3rd century BC. (Weeramantry, 1997). The term water and soil conservation ecosystems is therefore a more appropriate description. Thomas Tredgold's definition of Civil engineering as "the art of harnessing the great sources of power in nature for the use and convenience of man", has been incorporated in the charter of the Institution of Civil Engineers,

London. This conforms to the concept of dominating nature as against the concept of adapting to nature. The latter may be further subdivided into two categories, namely active adaptation, and passive adaptation. The ancient water and soil conservation ecosystems of Sri Lanka are a classic example of man's active adaptation to nature. These systems had been constructed over a long period of time, beginning in about the mid first millennium BC. There are three important aspects of these systems that merit study, namely

- their evolution and development over a long period of time
- their stability and sustainability over an even longer period
- their final apparently irreversible decline after about the 12th century.

These ancient systems consist of interconnected large reservoirs and channels, mainly in the ancient Rajarata or king's country, and cascades of small reservoirs called village tanks after the Portuguese tanque. Both sub-systems are necessary for irrigated agriculture in the way that both hands are necessary for all human activities. One can never hear the sound of one hand clapping. A map called the Water Resources Development Plan prepared in 1959 on a hydraulic engineering basis has been used to identify sites for new large reservoirs, ignoring the ancient ecosystems. (see Table attached). Two major reservoir projects, Uda Walawe and Lunuganvehera selected from this map, in the southern area, ancient Ruhunarata, have been responsible for destruction of some of the ancient ecosystems, and proved to be unstable, contributing to civil strife and insurrection in the early 1970's and late 1980's. Despite this, another large reservoir, Moragahakande, was selected from this map for costly Feasibility studies in the face of reasoned criticism, and was short-listed for foreign funding for construction recently. In the course of looking for alternatives based on the ancient water and soil conservation ecosystems, an unique large reservoir called Parakrama Sagara in ancient chronicles, was re-discovered. It is in fact a series of large reservoirs joined together by canals that had been surveyed and documented in 1855 by three British surveyors, Adams, Churchill and Bailey. (Brohier, 1934). Their report had been included in the inspection minutes of the Governor Sir Henry Ward, but ignored by irrigation engineers ever since. Instead, ancient ecosystems in the vicinity had been restored on a hydraulic engineering basis, thus obscuring the ancient Parakrama Sagara. This in itself is a fascinating story, specially because Moragahakande has now been shelved despite hectic lobbying.

A related development is the proposed Water Museum at Minneriya, another large ancient reservoir of about 2500 hectares built by king Mahasena (276- 303) and known to have been functioning continuously from the time it was built. This led to the Water Heritage of Sri Lanka under which a number of water heritage sites and monuments will be developed as water museums and centres, starting with Minneriya. In this connection this author who has done research on the subject for many years including at the Needham Research Institute, Cambridge, England, under the late Dr Joseph Needham, visited Museums and Science Centers in Canada and USA, and published a book titled Sri Lanka Water Heritage, recently. His visit was returned by the Director General of the Canadian National Museum of Science and Technology, Ottawa, and his wife, a Heritage Specialist in her own right, and a joint Water Heritage project is in the offing.

138. E.S. Mohochi, Kenya

The Search for, Storage and Management of Water and Its Implications on Women's Welfare Among the Kuria of East Africa: A Historical Perspective.

The Kuria, an African community in Kenya and Tanzania in East Africa, is one that holds to its traditions quite dearly. For instance, contrary to current thinking in most of the world, female genital mutilation is still widely practiced. Gender based role differentiation is one other cultural practice that is still strictly adhered to. This is despite the long time cross-cultural interaction that the Kuria have had with other communities and the rather modest gains made in education by members of the community. The bigger problem, however, is the fact that the distribution of roles is heavily imbalanced in favour of men. Consequently, efforts made by women to uplift their standards of living, in essence society's living standards have been greatly impeded by the numerous tasks that they have to contend with on daily basis.

This paper will investigate the predicament of Kuria peasant women with specific emphasis on the water question. A historical analysis of the situation will be attempted. Using the Kuria case, it will be interesting to establish whether, 43 years after independence, enough has been done to alleviate the burden that has to be endured by women in making water, a very important resource, available to the family. Do women still have to walk long distances in search of water; a practice that greatly affects the participation and attainment of the girl-child in education? Are there positive changes in terms of availability and quality of water? What steps should we take to better the current situation?

083. Dinkar M. More & G.G. Babar, India

History of Sewage Irrigation- A Case Study From Arid Zone of Maharashtra (India)

The famous historical city of Pune in Maharashtra, is a living example of both the success during the historical period and failure in the later period in implementing sewage irrigation on sustainable basis. It reaped very good results initially in the form of increased crop productivity and simultaneously protecting the quality of fresh water flowing through the rivers two in nos., right through the middle of the heavily populated city. It affected the river ecosystem very badly in later periods due to total disregard to the maintenance and upgradation of the re-cycling process.

The city is located in the catchment of Mutha-Mula, major tributaries of Krishna basin of penninsular India. The annual average yield through this catchment is around 1400 Mm³. It is an arid and water short basin with per capita water availability falling below 1000 m³. The dam at Khadakwasla commissioned in the last decade of nineteenth century could impound about 100 Mm³ of water. The remaining water was available for flushing the river courses during rainy season and maintaining the minimum flows in the rivers during post monsoon period. In the year 1929 when the sewage irrigation scheme was conceived by a great visionary and Civil Engineer, Mr. C.C.English, the Pune City had hardly a population of 1,50,000. The city could generate wastewater of the order of 10 Mm³ only. This quantum when compared to the annual availability of the fresh water in the rivers was insignificant one. This was also not tolerated and a scheme may be the first of its kind in the country, was made to function with a view to protecting the river eco-system and gain the benefits by way of increased crop production. The direct discharge of untreated sewage in to the rivers was thus considered highly objectionable by the then city Administrators.

The scheme of sewage irrigation was formulated on a scientific base. The used water from the city was collected, treated and supplied through "Bhairoba Pumping Station" to the nearby farms in the premises of Hadapsar, Manjari and Mundwa for growing all sorts of crops in a systematic way. It could grow crops like wheat, pulses, sugarcane, vegetables and floriculture intensively. The yield per hectare was exceptionally high in comparison with the conventional irrigation system. There was no damage to the soil structure. The growth of fodder crop enhanced milk production in and around the city. No farmer used external manure for improving the fertility of the land.

The re-use of wastewater in agricultural production thus proved as cost effective with minimal environmental impact. The manure rich sewage water improved the soil fertility too. The existing irrigation network of Khadakwasla project was used for sewage farming. Over the years the scope was extended over 1500 ha. The treatment given was of a primary nature and simple in operation. The effluent (treated used water) was found to be very rich in manure content necessitating the adoption of dilution process. The dilution was made with the fresh water of the adjoining canal system i.e. of Dy. 3, 4, 5 & 6 and required dose of manure was applied to the various kinds of crops. The scheme is being run by the local Government i.e. Pune Municipal Corporation and State Irrigation Department jointly since its inception.

As the population of city increased the consumption of fresh water, in other words generation of wastewater increased. It was obvious that, the capacity of the sewage treatment plant should also be increased simultaneously thereby bringing more area under sewage farming. This did not happen. The scheme ran unattended. Year after year due to poor up-keep, the availability of effluent was reduced and the area under service reduced to a meagre figure of 100 ha. The population of city has grown to an astronomical figure of 4 million or so, (2002). There is also a massive industrial belt around the city. To meet the increasing demand of water inclusive of irrigation, four more water storages (viz. Panshet, Warasgaon, Pavana and Temghar) holding water around 1000 Mm³ were created in the catchment on upstream thereby curtailing the availability of flowing water considerably.

The city is generating highly polluted water, both from its urban and industrial use to the extent of 300 Mm³ annually. During the years of deficit, there are no outflows in rivers. On the other hand the process

of generation of sewage through the urban and industrial use and its direct discharge in the rivers remained continuous. This 'point use' reduced the irrigation water of rural areas creating disparity amongst urban and rural.

Over the years discharges of un-treated sewage in the rivers exceeded 900 MLD. There was no fresh water in the river courses for the maintenance of minimum flows. The rivers started flowing with untreated sewage alone. The continuous discharge of the untreated sewage of above magnitude in the river beds developed an alarming situation posing threat to the ecosystem. The sewage treatment scheme conceived about 70 years ago had a capacity to handle a flow of the order of 50 MLD only. This should have been expanded to match with the increasing demand of wastewater. On the contrary same was allowed to degenerate out of sheer neglect. A major part of the area under sewage irrigation was also converted into non agricultural zone, with utter disregard to land use planning. The rivers of Mutha and Mula lost their riverine qualities and they remained no more than the drains carrying waste-water of urban and industrial sector. Breeding of harmful insects, mosquitoes, bacterias, aquatic weed growth and living with them became part of city life.

The historical innovative scheme of 'Bhairoba Pumping Station' was there in a dilapidated condition to guide the city planners and show the road ahead. A programme of treatment of city sewage in the various parts of the city has recently been undertaken. Out of 8 sewage treatment plants planned as phase-1, two (1) Pimpri Chinchwad Treatment Plant and (2) Naidu Treatment Plant have been commissioned. The old (faithful) is being upgraded. With these nine plants in use by 2005 or so, the city could treat a sewage of the order of 330 MLD. Right now the generation of sewage is around 900 MLD. Efforts are on to reverse the situation of converting the fresh water bodies into waste-water drains.

The process of generation of wastewater is going to be on increasing scale and to cope up with this, there has to be an effective follow up by way of implementing treatment process and expanding sewage farming on a sustainable basis. There are large no. of cities in this arid zone of Maharashtra. This is thus a message to all such urban centres. The increasing urban population is generating excess quantity of wastewater. Such innovative schemes of reuse needs to be brought into operation on an emergent basis for protecting the ecosystem and for increasing the food production. There are numerous other advantages too. It is a lesson learnt from the historical experiment put to practice on a tiny scale.

The article in detail narrates the various stages of development of sewage farming since beginning, its debacle in the subsequent period and finally reversing back to historical wisdom to overcome the situation.

177. Tanushree Mukherjee & Ranajit Gupta, India

Traditional Water Management – Historical Lessons from Cities

1. Introduction

Water management in rapidly growing cities has become crucial with competing demand, scarcity, pollution, depletion of water resource, illconceived projects, expensive network etc. Traditional concepts are being revived and lessons from history provide new ideas.

2. Lessons from history

Ancient cities were developed in the valleys of great rivers- the Nile, the Tigris, the Indus, the Ganges etc. Water was an important part in the civilization. Both in the Middleeast and India digging of canals, constructing wells and tanks were considered noble works. Both in Islamic and Hindu religion, water is used for purification. In the Indian sub-continent the Muslim rulers with the Arab and Persian backgrounds created reservoirs and canals to store run off from mountains and practiced rain-harvesting. When wells became silted or dry, water markets were established and mosquis or waterbearers carried water to the houses.

3. Water architecture

Aqueducts from the Roman times were landmarks. Well-designed stepwells were created in many ancient cities. They were centres for women's social gathering also. Steps, bathing kiosks etc. provided aesthetic river fronts. Varanasi in India is an example of such river front architecture. The Persian gardens in Iran and the Mughol gardens in India and Pakistan provided water as an element of urban design. This is part of bioclimatic design and passive solar architecture. The colonial rulers and the European influence neglected these. Water either dried up or became polluted. The import of technology on health ground brought pumps, pipes etc. with an expensive network. It is now necessary to preserve water architecture.

4. The Water ecosystem

The ancient cities of Mohenjodaro and Harappa in the Indus Valley and feautifully designed Fatehpur Sikri in Mughol India were ebandownd due to socity. The modern engineering aspects of water does not follow natural ecosystem. The bioclimatic design of cities with water and vegetation requires revival of some traditional concepts which may form a part of Integrated Water Resource Management. Canals, streams, rivers, lakes and other water bodies, during the last few decades have been silted or filled up or have become drainage channels. There is an increasing awareness for cleaning, preservation and development and reestablishment of water ecosystem in the cities.

060. Yurina Otaki, Masahiro Otaki & Osamu Sakura, Japan

Environmental History of Water Use in Tokyo

Constant acquisition of water has been one of the fundamental tasks for urbanized areas. At the first stage of urbanization, people used water from spring, river, lake or underground near the residential areas. After that, most of the cities experienced a population explosion by rapid urbanization, and it caused an insufficiency of water. It was the beginning of continuous efforts to secure enough water. Aqueduct was the first introduced technology to satisfy increasing demand. Its water was taken from the water source of good quality, and flew down for a long distance only by slant. For example, the large-scaled aqueduct constructed in 17th century in London brought water from far spring for 60 km. Most of the cities were always looking for new water source and constructing new aqueduct to satisfy the increasing demand. The second big change was brought by the innovation of the stream engine. Its ability to lift water realized to supply water for the wide areas regardless of altitude. However, continuous expansion of population and water use caused a large amount of wastewater beyond the natural capacity, and its discharge threatened the sanitary condition: drinking water was polluted, and water-borne diseases such as cholera and typhoid fever, which spread through patient's excrement, were prevalent. To improve such a poor sanitary condition, modern water supply and sewerage system have been introduced.

Similarly, there were many efforts to get enough water of good quality and to realize good sanitary condition in Japan. Especially, Tokyo, which had been called Edo until 1868 and was very small city in the beginning of 17th century, experienced very big changes. After the Tokugawa shogunate brought the capital function here in 1603, it grew more rapidly than it had been experienced before. The population density reached very high, because more than one million people lived in the area of 100km². As there was not enough drinking water in Tokyo, they spent a hard time to establish water system ("Edo water system" (EWS)), such as aqueducts. EWS worked well until 19th century, when cholera prevailed and the sanitary condition got serious. This became the driving force to change the EWS to modernized one by imitating Europe.

In this paper, we focus on the period in which the water system changed from EWS to modernized one, and investigate what the advantages and disadvantages of EWS were from the sanitary point of view. We assume that the conclusion of this study is thought to be useful information for considering more applicable water system that will be applied to urbanizing areas.

189. Prabhath Patabendi, Sri Lanka

Hydraulic Civilization in Sri Lanka - A Case Study of "Sigiriya Water Grdens 477-495 AD" a World Heritage Site.

Historians studying the rise and fall of Sri Lanka's ancient hydraulic civilization have marveled at its engineering technology and water resource management. The establishment of forests and construction of ponds, reservoirs and irrigation systems were considered great meritorious acts in accordance with popular Buddhism, the faith of the leaders and the large majority of people in Sri Lanka. Our history is full of achievements of kings who contributed to the development of water resources. Since the first century AD kings built numerous reservoirs and irrigation systems. An indigenous expertise developed over the centuries which appears to have been called upon by other countries of South Asia.

Sigiriya now a world heritage site and regarded as the 8th wonders of the world was created by King Kasyapa who reigned between 477-495 AD. The summit of this almost inaccessible rock is 180 m (600 ft) above the surrounding jungle and was the setting for a courtly paradise of elegant pavilions amid gardens and pools. The rock was transformed into a recumbent lion by the addition of a brick-built head

and foreparts of which only the paws remain. The rock's natural defences were augmented by broad moats and stone perimeter walls. In the event of an enemy approach, the outer moat was built so as to flood the entire area between the two moats.

Sigiriya water garden was created 5 centuries before those at Angkor in Cambodia or Mughal gardens in India. The central island would have been occupied by a large pavilion. The terraced gardens slope down to the boulder gardens and then to the geometrically laid out water gardens, with running water and fountains, pools and ponds, aquatic flowers and birds, and tropical trees. The entire water garden is in a walled enclosure. The miniature water garden was discovered not long ago. It has winding waterways, shallow reflecting pools, co belled watercourses, marbled floors and an intricate layer of tiled roof buildings. Adjacent to this is a central island surrounded by four L-shaped water pools. These pools appear to have been used as bathing pools. These had polished walls, flights of steps and surrounding terraces - similar to a modern-day swimming pool. There are fountains fed by water under gravitational pressure from the artificial Sigiriya Lake. Symmetrically perforated limestone plates fashion their spouts. These fountains operate in rainy weather even today. An octagonal pool is set at the transition point from the water gardens to the boulder gardens. It is surrounded by a wide terrace, which follows its shape. A gigantic boulder almost the height of a six-story building shelters the pool. This paper will analyze the rise and fall of Sri Lanka's hydraulic civilization with special preference to engineering technology applied to create Sigiriya Water Garden.

167. Shavkat A. Rakhmatullaev, Dilshod R. Bazarov & Jusipbek S. Kasbekov, Uzbekistan

Historical Irrigation Development in Uzbekistan from Ancient to Present: Past Lessons and Future Perspectives for Sustainable Development

The paper discusses the four main historic periods of irrigation in Uzbekistan. They are known as ancient times, feudalism, Soviet era, and post-independence periods. The authors argue that this division enables readers to better visualize and understand the irrigation developments. The infrastructure, management hierarchy, the water allocation issues are discussed. Uzbekistan is one of the most ancient areas of irrigated agriculture. Here, as well as in all countries of the East and arid zones, "the climatic conditions have forced development and use of primitive artificial irrigation infrastructures to grow food and sustain livelihoods. Ancient civilizations have risen and fallen due to irrational water management and water wars on water. The research and archeological studies indicate the existence of Ancient farming culture of Margiana, Sogd, Fergana, Khoresm, Northern Baktria and ancient irrigation lands in lower reaches of Amudarya, Syrdarya and Zarafshan rivers and have shown that irrigated agriculture in Central Asia originated mainly in two geographic hydrologic favorable zones: in valleys of foothills and flood-lands or deltas of great flat rivers of Syrdarya and Amudarya.

For example, the interesting water allocation mechanism was practiced in the region. Most important government official was the chief Mirab who had considerable Distribution of water at a village level was overseen by a water controller, the Mirab, who in turn, was supervised by a village elder who was elected by the people. It was the responsibility of the Mirab to ensure that every one linked into the irrigation system received their fair share of water.

Improper management and decisions have caused severe environmental problems such as desiccation of Aral Sea. Like the Tsarist rulers before, the Soviets believed that Central Asia could become a major cotton growing region if the irrigation network was expanded. But while Tsarists plans failed because they were dependent on financing from the private sector, the Soviets covered the construction costs of large scale irrigation schemes from central funds.

In order to sustainable development of the region and rational natural resources management without harm to environment and economies, local policy makers and planners and international institutions that are actively participate in funding irrigation projects need to know the history of irrigation development of the region and learn past failures for future successes stories.

069. C. Ramachandraiah, India

From Historic Water Sources to Objects of Real Estate. An Analysis of Disappearing Water Bodies in Hyderabad, India

The present paper analyses the historical importance of water bodies, their extinction, encroachment and pollution due to urban sprawl, and the efforts of civil society organisations to protect them. In the undulating topography of the Deccan Plateau in peninsular India, Hyderabad city and its environs have been blessed with a number of natural and man-made water bodies (lakes, tanks and cheruvus). Many big tanks were built by the Qutub Shahi rulers (1534-1724 A.D.) and later by the Asaf Jahi rulers (1724-1948 A.D.) in and around Hyderabad city.

The two large water bodies, the Hussain Sagar (built in 1575) and the Mir Alam Tank (built in 1806 by French engineers) provided plenty of water supply and the cholera disease was not known for several years. The water of a reservoir, Musa Bam built in 1770 A.D, was known to be so good that whenever the Kings of Hyderabad went out of their Dominion, 'this water was dispatched everyday to the Royal camp as far as Delhi and Simla', which are located more than 2000 km away.

Hyderabad urban agglomeration has grown from a city of about 1.25 million population in 1961 to about 5.5 million in 2001. It has registered a decadal growth rate of about 43 per cent, 67 per cent and 28 per cent during seventies, eighties and nineties respectively. Non-implementation of building regulations due to rampant corruption in the revenue and town planning departments have encouraged the illegal constructions on a large scale resulting in the disappearance and shrinking of many water bodies over time. In addition to this, they have been polluted due to discharge of untreated industrial effluents and domestic sewage thus making their waters unusable for any useful purpose. The water channels, which carried floodwaters from one tank to the next in a catchment area, have also been encroached by private and government agencies. The decline of water bodies has also led to increasing water scarcity.

The National Remote Sensing Agency (NRSA) found that there were 932 tanks in 1973, which came down to 834 in 1996 in HUDA (Hyderabad Urban Development Authority) area. The area under water bodies got reduced from 118 to 110 sq.km. and about 18 larger tanks and 80 tanks of below 10-hectare size were known to have been lost. Another study based on remote sensing data on 1: 50000 scale revealed that the area under water bodies got reduced from 22.79 sq.km in 1989 to 20.84 sq.km in 1999 in Hyderabad and its immediate environs. Micro level studies would indicate much more reduction in the area under water bodies.

The 169 lakes notified by HUDA cover an area of about 90.56 sq.km. The concerned authorities do not enforce several measures notified for their protection. The HUDA seems to be more interested in beautifying the lakes and promote tourism with private sector participation rather than involve local communities in preserving and managing the water bodies.

From 1993 onwards, local citizen groups became active in highlighting the damage to the water bodies. Despite the High Court intervention for protection of water bodies, enormous damage has been caused to them. Water should be treated as the ecological foundation of all life and as a common property resource for all living beings. Accordingly, protection of water bodies from encroachment and pollution should be given high priority to ensure water security in future.

033. Martin Reuss, USA

Geomorphology and the Rise of Modern Hydrology

Geomorphology—"the scientific study of the geometric features of the earth's surface"—changed hydrology from a primarily engineering discipline into one that also could contribute to important scientific research.

The integration of descriptive and then quantitative geomorphology into hydrology led to a greater appreciation of the relationship between land and water and focused attention on the evolution of river basins. The Scottish fluvialist John Playfair in 1802 first drew correlations between river shape and length and the shape and size of the basin. Others followed with attempts to classify stream branches into various orders. Much of this work took place in the American West in the last decades of the nineteenth

century. The American geologist Grove Karl Gilbert discussed the impact of streams on the formation of slopes (and vice-versa). His reductionist approach offered explanations that today may seem obvious, even simplistic, but in fact reflected important imaginative leaps. Essentially, Gilbert saw the Earth's landforms working towards a state of "dynamic equilibrium" in which the forces of erosion (including water) are equal to the forces of resistance.

Others followed Gilbert. Perhaps most important was William Morris Davis, an American geographer who popularized Gilbert's (and Playfair's) emphasis on the continuity between a river system and its drainage basin. Davis's idea of a landscape's "geographical cycle" of youth, maturity, and old age heavily influenced early 20th century thinking about drainage basins. In Davis's concept, the river dominates, as it sculpts valleys, gorges, waterfalls, and similar dramatic features.

But Davis's explanation of the relationship between a river system and a drainage basin lacked any kind of quantitative explanation. Robert Horton deserves credit for transforming this descriptive art into quantitative science. His 1945 article suggested a mathematical relationship between the total length of the streams in a basin and the area of the drainage basin. The article initiated a general re-evaluation of Davis's work. Professor Arthur Strahler of Columbia University, a geologist, decried Davis's methodology and offered a "quantitative-dynamic approach based on empirical data and quantitative laws." Geomorphology was "not a nature-lover's hobby, but a geophysical science of almost terrifying complexity." Strahler stressed the use of mathematical models, modifying some of Horton's theories.

Meanwhile, the Water Resources Division of the U. S. Geological Survey, under the direction of Luna Leopold, integrated quantitative geomorphology into hydrology. Leopold and Thomas Maddock showed a mathematical relationship between river cross-section and discharge. With Walter Langbein, Leopold applied ideas about randomness and entropy to stream development, suggesting that "the most probable condition" of a river system exists when energy "is as uniformly distributed as may be permitted by physical constraints." By the 1970s, quantitative, theoretical geomorphology was firmly integrated into hydrology, enabling the discipline to address fundamental questions about the physical and chemical relationship between land and water.

115. Owen Roberts, UK

Pride and Pestilence: Epidemics, civic identity and ideas of water-transmitted disease in nineteenth-century Britain.

This paper will study the response of towns in late-Victorian Britain to the onset of water-borne epidemics, and in particular typhoid fever. It will focus on how such responses were informed both by various theories of disease and by the self-image of the urban community. The issue of how best to cope with a typhoid epidemic could become intensely political.

Recent studies by Hamlin, Worboys and others have problematised the issue of how ideas of disease were perceived and applied during the late-nineteenth century. This era may have been on the cusp of the 'bacteriological revolution', but many different interpretations of the spread of disease were possible, and public health science was far from being politically neutral. This paper will explore how urban decision-makers were influenced by various interpretations of disease theory, and how they coped in a situation where there was conflicting expert advice.

The paper will also deal critically with the issue of civic identity. Traditionally, historians have seen the growth in civic identity and municipal power in Victorian towns as a major factor in the improvement of sanitary infrastructure, and have regarded the great water schemes of the late-nineteenth century as one of the crowning achievements of the great city governments of Britain. While not entirely rejecting this hypothesis, this paper will argue that civic pride could also be a hindrance to the effective combating of outbreaks of water-transmitted disease.

136. Florian Ruhland, Germany

Little Venices in pipes: Water and environment in pre-industrial cities in Central Europe and what we can learn from it

This paper deals with water supply and sewerage as a part of the environment of pre-industrial European cities in the perspective of historical geography. The starting-point is the attempt to reconstruct (and deconstruct) the urban environment in Central Europe before the 19th century, about which our knowledge is quite poor. A lot of long-established myths, images and prejudices exist about the pre-industrial urban environment and about the way citizens dealt with it in the

middle ages and early modern times. But they are not appropriate, because it seems that quite a lot of them are perceptions made up in the environmental crisis of industrializing cities in the 19th century, when modern centralised water supply and sewerage systems were introduced.

The results of a lot of disciplines and sub-disciplines must be taken into account, which represent plenty of approaches to the city and its environment. They range from urban ecology, urban geography, urban (environmental) history, urban archaeology to urban engineering. But as urban ecology has been able to just develop partial models even of contemporary cities, historical investigation can't be holistic, but must be rather reduced to a core.

Water in the urban sphere is investigated in this paper under the main question, how the infrastructure of water supply and sewerage changed the "natural" urban environment and the urban cultural landscape, and why this infrastructure was shaped the way it was. Case studies are the cities of Prague and Nuremberg. An elaborated system of water supply with wells and pipes, in which water was pumped from rivers or the ground, developed from the late middle ages down to the early 19th century. These early water works and the connected networks of pipes can be described as "proto systems", a term introduced by Martin Melosi for early 19th century America. Very instructive and by then not exhausted sources of information about the pre-industrial urban water networks are plans from the 17th and 18th century as well as municipal books of pipes (in Nuremberg: "Röhrenmeisterbücher") and municipal books of wells (in Nuremberg: "Brunnenbücher"), which exist since the 15th century. These sources show, how the networks were adapted both to the local topographical and hydrographical conditions and the economical requirements. Taking into account the smaller surface areas of pre-industrial cities compared to the cities of today the length of the networks is impressive. Following André Guillerme who has stated that pre-industrial cities in northern France looked like "little Venices", a lot of cities in Central Europe could be described as "little Venices in pipes". A future perspective is to compare more cities than Prague and Nuremberg with the technology of a GIS.

Realizing a crisis of current centralised water supply and sewerage systems even in humid regions of the world one could think about a reconsideration of some characteristics which contributed to the stabilisation of the pre-industrial use of water in cities without neglecting its limits and disadvantages. This didactic aspect of water in pre-industrial cities could be important with the current plans of rebuilding urban infrastructure in western societies and with the building of urban infrastructure in less developed countries.

056. Zekai Sen, Saudi Arabia

Historical Water Supply Structures in the Arabian Peninsula

Abstract: Water has been the vital survival commodity for human, animal and plant life in any environment. However, in extremely arid and arid regions its availability is very scarce and hence human beings have sought special technologies for water supply. Especially, rainfall harvesting technologies as surface water and groundwater recharge possibilities have been used in the Arabian Peninsula where evaporation rates are very high. On the other hand, in order to lead the main water resource which is the groundwater, qanats have been constructed along potential wadis in order to augment the permeability in some part of the unconfined aquifer. This technique has been used in almost all the then Islamic countries including Andalusia in Spain. Their remnants are in many places all over the world, but the most famous one is in the Wadi Na'man which is known as Ayn Zubaidah water way. This qanat way is still functioning in wet periods of the year when the groundwater level is raised after significant recharge phenomenon. On the other hand, large diameter wells are scattered all over the country some of which are as old as 1500 years.

It is the purpose of this paper to mention about the significance of rainfall harvesting, qanat and well designs as they used to be in the past and their possible importance for water stricken areas of the world today. Detailed explanation of qanat construction and operation principles according to present day scientific principles will be explained. Old water haulage techniques from the wells are explained with detailed figures, in addition to the history of water rights in the Arabian Peninsula.

139. M. Shirani & M. Shahvali, Iran

Study of Native Waterharvesting Construction Sustainability (Abanbar) in Larestan District of Iran.

The most important factor for sustainable development is access to rich water resources. In Iran, low rainfall and its irrelative dispersion cause catastrophe each year: famine and flood. In such conditions, provision of water for present and future generation is vital. According to this fact, the Iranian, have invented various methods to provide water to challenge the above mentioned catastrophes for centuries. For example, in southern part of Iran, the people of Larestan district in Fars province (Iran) have overcome water deficiency and brackish by Abanbars. Abanbar is a water harvesting construction that is widely used for more than 4000 years in Iran. However, there is still a question: Are Abanbars sustainable enough for people activities in long term? This study used sustainability approach to answer this question.

In this approach water resources, which are sustainable environmentally and economically and provide sustainable social conditions for people, are sustainable. The general objective of this study was testing the above hypothesis about Abanbar. This test was conducted by survey method. Ninety-seven Abanbar users were selected by classified random sampling technique and they were interviewed by open and closed-ended questionnaire. The questionnaire was qualified by face validity and reliability tests.

The results indicate that Abanbars are sustainable "socially", "economically" and "environmentally" and their sustainability is according to special culture in the district. To access sustainable water resources in future the study suggests paying more attention to native waterharvesting methods to remove water deficiency problem. To work more for reviving, optimization, repair and protection of Abanbars in such a manner that result in better water quality. To prepare a technical manual based on the results from this research and other experiences to help people how to establish, maintain and use Abanbars in more sustainable manner.

087. Gunta Springe, Latvia

The development of drinking water supply system for Riga City, Latvia, Baltic States

Riga, the capital of Latvia with 735 000 of population, was founded in 2001, and today it is the largest city in the Baltic States. Riga is situated on the both banks of the Daugava River 13 km from its estuary into the Gulf of Riga, Baltic Sea. Inhabitants of Riga used the water of the Daugava River and that of protection canals of the town in the Middle Ages - the first water supply device in Riga was built in 1620 to take water from an open reservoir. The plunger pumps of the devices were driven by horses, and the water ran through wooden pipes to pools and to some houses of Riga's noblemen. A new pump station began to work in 1863 using water from the Daugava. At the beginning of the 20th century, the quality of water in the Daugava changed for the worse, and at the end of 1904 ground water intake station was put into operation.

After World War II the industrial production of Riga grew along with the size of population, and since 1979 the main and unlimited water supplier is the drinking water station taking surface water from the Daugava. It was connected with the building of Riga's HPPs and upbuilding of reservoir. The designed capacity of the station at the beginning of operation was about 200 000 m³ of water per day but the of water use for Riga at present is 150 000 – 170 000 m³ of water per day.

However, in the middle of the 1980's, with a change in drinking water standards, productivity of the station was reduced to meet quality requirements. Providing of good quality drinking water is one of the main goals for National Environmental Policy Plan for Latvia. The pre-existing treatment chain (pre-chlorination - flocculation sedimentation - sand filtration - post-chlorination) was no longer sufficient for fulfilling the limit values required today accordingly European Standards. In particular the content of biologically available, organic substances (AOC) contained in the water must be strongly reduced. Thus the most important task of municipal enterprise 'Riga Water' supplying the city with drinking water became implementation of the internationally financed Riga Water and Environment Project directed to establishment of safe and high quality water supply in Riga and treatment of all wastewater according to modern requirements.

During more than two years different process combinations were checked by pilot trials. Now the existing sand filters are converted into with air and water backwashable multi layer filters. The filtrate is treated with ozone in an oxidation/disinfection step and flows into the following, new biologically operating filter step reducing AOC. The ozonization step guarantees a complete disinfection, eliminates colour and taste causing contents and improves the method of operation of the following, by the majority biologically operating filter stage. The network protection is still implemented by addition of chlorine gas, whereby the consumption of chlorine has been highly reduced.

187. Aysen Türkman & Ünal Ösis, Turkey

Historical Waterworks in Turkey

1. Hittite and Urartu Periods in Central & Eastern Anatolia (2nd Millenium BC - First half of 1st Mill. BC)

Turkey was at the crossroads of ancient civilizations and constitutes one of the world's leading open-air museums with respect to ancient water works, some of them being still in operation. The most ancient remains of waterworks in Turkey date back to the II. Millenium BC, the Hittite period in Central Anatolia, like the Karakuyu dam, the springwater collection chamber in Bogazkale, and some others. From the first half of the I. Millenium BC, the Urartu period in Eastern Anatolia, there exist various remains of dams and canals, some of them still in use like the 56 km long Samram canal, the dams at Kesis and Doni lakes.

2. Hellenistic, Roman, Early Byzantine Periods in Western & Southern Anatolia (Second half of the I. Millenium BC - End of the I. Millenium AD)

Remains of Hellenistic and especially Roman and early Byzantine waterworks in Western and Southern Turkey, from the second half of the I. Millenium BC to the first half of the I. Millenium AD, are very numerous and new discoveries add to the rich variety of them. Noteworthy are the 240 km long water conveyance system to Istanbul, the almost 100 km long system to Phocea, up to 65 km long systems to Pergamon, up to 43 km long systems to Ephesus, others to Smyrna, Priene, Miletus, Alabanda, Laodicea, Xanthos, Patara, Perge, Aspendos, Selge, Side, Diocaeserea, Olba, Elaiussa, Samosata, Amaseia. They encompass aqueducts up to 40 m height, tunnels of over 2 m height, inverted siphons up to 190 m pressure, lead-, stone-, clay-pipes of various sizes, rock-cut and masonry canals, springwater collection chambers, city reservoirs, water distribution and sewerage networks. From the same period date also diversion tunnels like that in Seleuceia Pieria, tunnel-like superstructures on creeks like those in Pergamon and Nysa, with diameters up to 9 m; dams like the 10 m high Çavdarhisar, 16 m high Örükaya and some others. Covered and open cisterns in Istanbul, with side lengths in the order of 150 to 250 m, are extraordinary examples of antique cisterns.

3. Seljukide & Ottoman Periods in Anatolia & Thrace (10. - early 20. Centuries)

There are certain remains from the Seljukide period in Central and Eastern Anatolia, from 10. to 13. centuries, like the water conveyance canal to a mill in Çermik, the Sahip Ata irrigation canals in Konya, irrigation systems in Eregli and elsewhere. Among the remains of waterworks from the Ottoman period in Turkey, 14 to 20 centuries, those for Istanbul and Edirne deserve particular interest. The Halkali conveyance systems to Istanbul, constructed in the period of 1450's to 1750's, consist of 16 systems with a total length of 130 km, including the 50 km long Süleymaniye by Sinan the Architect in 1550's. The 50 km long Taslimüsellim system to Edirne, is also considered as a work of Sinan, dating from 1530's. The 55 km long Kirkçesme system to Istanbul from 1560's, is one of the masterworks of Sinan, with four major aqueducts (Uzun, Egri, Maglova, Güzelce) up to 35 m height and 700 m length. The Taksim water conveyance to Istanbul from 1730's and the Üsküdar systems east of Bosphorus from 16. to 19. centuries are also noteworthy. In the period of 1620 to 1839, the Kirkçesme system is supported by four, the Taksim system by three dams, with heights up to 17 m and crest lengths up to 104 m. All these dams, Kirkçesme and Taksim systems as well as the Taslimüsellim-Edirne system are for the large part still in operation. The diversion of Gediz river to prevent the closure of the Izmir bay in late 19. century; Beysehir-Çumra irrigation south of Konya in early 20. century; the generation of the first electricity in Turkey in 1902 at the Tarsus hydroelectric scheme are other interesting achievements at the down of the Ottoman Empire.

166. Pieter A. van Brakel & Sam Berner, South Africa

Challenges and advantages of establishing an information portal for an information system on water research.

Portals, a further development from what has become known as a Web-based directory of information hub, and particularly so-called information portals, present unique strategic challenges in any research environment. An information or content portal is able to organize large collections of content (information resources) and based on the subjects they contain, can more effectively connect the right people with the right information. Two types of information resources are referred to: Internal, institutional and/or unpublished research-based content, as well as external content, such as large commercially available bibliographic and full text databases, news feeds, research results databases, dissertation databases, and so forth. An enterprise or institutional information portal has the capability to link and integrate internal with external content.

To put information portals into perspective, three generations of Web environments can be distinguished in an effort to indicate more clearly the features of a portal:

§ An Internet Website, the most basic manifestation of Web, allows end-users to search for digital documents on water research and following relevant links to other resources; "... it is intended for public consumption without restriction".

§ An intranet Web, developed for the staff of an enterprise, concentrates on providing relevant information solutions to an internal community; access is limited to an authentication process.

§ On the contrary, a portal is a sophisticated gateway to the Web that allows the plethora of information on Internet and intranet Web sites to be organised and customised and personalised through a single entry point.

The following elements provide a more detailed analysis of the information portal - a mechanism that should be built into any environment where research on water, and the history of water, is taking place:

§ Access point: A single gateway or logon to identify approved users. This refers to a desktop-orientated function: it prevents the user from having to sign onto each of the different systems that provide portal content.

§ Internet tools: These are site search and navigation tools to provide users with easy access to information. Examples given are calendars and planners to allow users to input and share events, as well as Web site and content builders, offering them the ability to create and have customized content being made availability according to individual profiles.

§ Collaboration tools: These include e-mail, threaded discussions, chat and bulletin board software that offer a whole range of ways to communicate and share information.

§ User customization: A typical portal prompts the first time user via a series of fill-in windows to provide information about him/her. This is then stored in the portal's database. When that user authenticates to the portal, this information will determines what he/she will see on the homepage immediately after login.

§ Channel information: User-defined channels from both internal and external (information sources). Examples are, inter alia, research information, statistical or assessment information, and links to other useful sites.

§ Pushed information: This refers to user-defined and selected content which is sent to legitimate users, such as news, events or specialised memos.

§ User personalisation: A good portal let you take customisation one step further, that is, to enable an end-user to subscribe and unsubscribe to channels and alerts, set application parameters, create and edit profiles, add or remove links.

This paper will investigate portals from an informational departure point, and concentrate on the last four elements of the above list: Customisation, channelled information, pushed information, and user

personalisation. The topic of water research, and specifically the strategic role that an information portal can play in this type of research, will be discussed in detail. A taxonomy of water information resources will be presented, indicating how these resources could be effectively made available to researchers in the various water research disciplines.

067. Shen Yuling, China/Norway

Land and Water Resources Management in Xinjiang Uygur Autonomous region, China

Xinjiang Uygur Autonomous Region is located in the Northwest of China and covers an area of 1.6 million km². The Tarim Basin, covering an area of half a million square kilometres, is the largest inland basin in the world. In the basin lies Taklamagan desert, which is the second largest desert in the world. The climate of Tarim Basin is characterised by hot summer and cold winter. The annual precipitation in the lowlands is only 50-70 mm with no particular seasonality. Evaporation of free water in the same area is 2000-3000 mm per year. Due to the low precipitation, agriculture in the lowlands is completely based on rivers originating in the mountain areas where rainfall is more abundant.

Irrigation agriculture in Xinjiang has a long history, in 1949 the cultivated area was about 1209.7x10³ ha., population was 4.33 million, and Uygur minority accounted for 75.9%. After 1949, under the ideology of "exploit Xinjiang, construct Xinjiang, defend Xinjiang", the amount of irrigated land had been substantially expanded with the immigration into the region. In 1998, cultivated area was 3310x10³ ha. population was 17.47 million, Uygur minority accounted for 46.6%.

This expansion of cultivated areas due to planned immigration and agricultural expansion has set off a number of unfortunate land degradation processes found in many areas of the basin:

- Due to increase of cultivated areas and water withdrawal in the upper reaches, there is an increasing water shortage in the lower reaches. This leads to land being abandoned, ultimately leading to desertification in the oases fringes.
- Excess use of irrigation water combined with a non-existent/inefficient drainage system in the upper reaches leads to a rise in groundwater table. Combined with high evaporation rates this has led to increasing problems of salinization in the lowland oases where in some cases large areas now is wasteland unsuitable for cultivation.
- There is a lack of suitable outlets to drainage water, and drainage water with high levels of mineralization, chemical fertilizer and pesticides flow into lower irrigation canals. This leads to deteriorating water quality in lower reaches, causing serious health problems of people living downstream.

There are large areas of arable land resources but water resources are limited in the region. How to allocate and manage water among different users, especially between old farmlands and land reclamation, how to coordinate the relationship between upper reaches and lower reaches, between agricultural production and environmental protection, are complicated and need to be studied further more.

058. Zheng Xiao Yun, China

Ethnic Water Civilization and Irrigation in Red River Reaches

Red River is an important river in Asia which is coming of Yunnan Province of China and passing Vietnam into the ocean. The bigness of the river not just because it is a big river but also by the grandiose terrace landscape and water civilization that has been existing in the reaches for hundreds years, which was created by the ethnic groups whom living in the reaches of the river and that is still known few by the outside. Depended on the water resource conditions, people created the terraces largely for millions Ha from altitude 400 meters to 1800 meters that some are near 1,000 classes, and great water irrigation system to support the terraces among the reaches. As well as water was used popularly as an important energy for rice and foods making. For this matter, water and irrigation was became the key in the society and it was broadly connected with the people's ideal, religions, social organizing and social life in the different ethnic group in the reaches, for example, the traditional social institutions was formed closely depend on the water resources management.

On other side, the Water civilization has playing an important role in the ecologic balancing in the contemporary development, traditional water ideal and the restrictions of water protecting is high valuable for people to keeping water sustainable use. As a kind of important " social capital" , the water civilization has high values in the present development but it is facing more and more impact with the development, population growing, environmental reducing and so on. This paper will focuses on the history of the irrigation and water use of Red River reaches, and the water related social institutions, ethnic cultures and its change. The values of ethnic water culture and the traditional knowledge of water resources using in the processing of the development.

C. The History of Water: Law, Economics and Politics

071. Joseph A. Adelegan, Nigeria

The History of Environmental Policy and Pollution of Water Sources in Nigeria (1960-2003): The Way Forward

Water pollution have continued to generate unpleasant implications for health and economic development in Nigeria and the third world in general. In the West African sub-region (with significant contribution from Western Nigeria) there are estimated 4 million cases of guinea worm, while about 500 million cases of trachoma leads to blindness of about 8 million people each year. However, despite the public and international agencies' policy focus on this problem, the situation in Nigeria seems degenerating and therefore demands increased attention.

Right from the inception of British Rule in the 1900s in Nigeria, the colonial economic development policies and plans contained little or no stringent rules to conserve the natural resources or to limit water pollution. Later the 1979 Federal Constitution focussed on environmental hygiene, with emphasis on refuse disposal, and liquid and solid wastes management in abattoirs, residential homes and streets, all of which came under the supervision of local government councils.

Thus the formative years of institutional environmental regulation in Nigeria could be said to have been characterized by the absence of clear scientific criteria and standards on toxic wastes and on pollution levels, while the enforcement of basic environmental and household hygiene depended largely on qualitative legal rules.

However, the discovery of an Italian ship in May 1988 of some imported toxic chemical wastes, made up principally of polychlorobiphenyls and the hostile media reaction that accompanied the discovery hastened the creation of the Federal Environment Protection Agency since Nigeria lacked both the institutional and legal framework to tackle the issue. Hence, in December 1988, as part of the emerging coordinated approach to environmental issues, the agency was established by decree.

So far, there are no clear formulated policies in Nigeria aimed at coordinating and monitoring the relationship between environmental management and sustainable development. This is in spite of all the efforts of the Federal Environmental Protection Agency. Presently, the environmental protection legislation in Nigeria is poorly enforced. There are no incentives for the adoption of pollution abatement measures and very few disincentives for polluting the environment.

Hence, experience from Nigerian environmental policies and implementation has shown that the traditional command-and-control system to environmental management had not produced the desired result both economic and environmental wise. There is hence the need to examine the potential of a mixed environmental policies involving the use of market-based instruments to complement the traditional command-and-control system in achieving economic efficiency in the use of the resource.

The target of this paper is for policy makers to be better informed on everything they need to do to make the market-based instrument work. Hence, policy makers need to understand the extent to which resource and environmental conditions impinge upon macroeconomic performance. Bad resource policies can actually hurt long-run economic growth by dissipating the wealth inherent in natural resource stocks. Excessive water pollution levels damage not only economic assets but human health as well. Excessive levels of water pollution-linked illness result in loss productivity, and excess levels of mortality imply substantial welfare loss

151. Olatundun J. Adelegan & Joseph A. Adelegan, Nigeria

The History of Water Services Finance in Sub-Saharan Africa: Pre and Post Colonial Evaluation in Nigeria

International agreements such as the UN Millennium Declaration, the Johannesburg Earth Summit and the World Summit on Sustainable Development have as one of the specific targets halving the proportion of people without safe drinking water by 2015. However, the present policies, institutions and practices in the delivery of water services in sub-Saharan Africa are failing in their impact on the people.

The Federal and State governments in Nigeria are cutting back funds on water supply, yet the population is increasing, water usage is also increasing and there is increased need for new capacity expansion and water system replacement. The increase in financial responsibility for water services is worsened by galloping inflation and historically high interest rates. All these have contributed to escalation in the operating and maintenance costs of water supply in Nigeria in postcolonial years.

This paper examines the advantages and disadvantages of various policy options available to Oyo State in Nigeria for assisting with the financing of water service. Pre and Post Colonial patterns of financing water services and their impact on the people is reviewed. Alternative financing options are examined. This includes sources of finance for capital and recurrent expenditures, such as financial provision for investment in new facilities, the extension, replacement and modernisation of existing assets, routine and periodic maintenance of assets, operating costs of systems and the overhead costs of water services.

Alternative financing options for Oyo State and local government include grant and loan programmes, user fees, programme aimed at reducing inflation and interest rates, privatisation of water services, lease / purchase financing and capital market financing through issuance of bonds.

However, there is need to create an enabling environment in which the financial community, be it public, private, internal or international, can bring more finance into the water sector. This will require drastic reforms in the way the water-based industry is organised and delivers services. Institutions in the water services sector need to be more efficient, responsive to clients, financially solvent and commercially astute.

These changes are necessary for the sector to generate and attract increased volume of finance. Part of the finance needed for new investment in the water sector, as well as recurrent operations will have to come through water charges from the users themselves, through water charges. Loans and private equity are ultimately paid from future cash flow from users. The water industry is traditionally a poor prospect for commercial finance. There is therefore need to maximize local funding since cash flow from water is in local currency. Local capital markets in Nigeria can be encouraged to yield more funds for the water sector.

175. M. Khorshed Alam, Bangladesh

Citizens' Movement to Save the Buriganga River in Bangladesh

Dhaka City, now the capital of Bangladesh, was established and developed on the bank of the Buriganga River in the early 1600s as a provincial capital of the Mughal ruler mainly because of easy riverine communication. Over the years, along with residential development, many industries and factories have been developed on the bank of the river using it as a "natural sink" for both solid waste and industrial effluents. The river plays a very significant role in providing sanitation, water supply, drainage, riverine transportation and flood control for Dhaka City. However, although the Buriganga River is considered to be the lifeline of the capital, within the city the river has become biologically and hydrologically dead in recent years because of indiscriminate dumping of domestic and industrial wastes, encroachment by illegal structures, and failure on the part of the authorities to enforce rules and regulations pertaining to ecological health of the river. Government response has been very little, except to form committees to examine the extent of damage done to the river and finding its causes, and lofty promises to save the river. Against the backdrop of

failure on the part of the government to respond to a call for immediate action, a group of people from within civil society emerged and formed a pressure group. So far this group has had some successes in highlighting the importance of the river for the existence of Dhaka City to policy-makers and the public. As a result, unabated encroachments have been stopped, some illegal structures have been removed from the riverfront, and a proposal is underway to establish a wastewater treatment facility.

The paper describes the uses of the river and historical development of the riverfront as a major source of recreation and sites for industrial growth as well as the way the river's health has deteriorated. It gives the history of the river turning from the lifeline of the capital city to a biologically and hydrologically dying river. The paper focuses on the on-going struggle of the citizen group trying to save the river through developing awareness among the public about the carrying capacity of the river and to create pressure on the regulatory authority to adopt adequate measures to undertake the cleanup programme for the Buriganga River.

182. Isameldin Abakar Atiem & Ferhat Türkman, Turkey

Hydro-politics History of the Nile Basin: From disputes to solution

In recent years, world trans-boundary watercourses are shaped with conflicts and disputes, internationally, and regionally these conflicts can be attributed in different viewpoints. Nile river is a trans-boundary river, and its hydrologic flow quantity regimes are highly variable from year to year. Consistently, this variability may not help water administrations in providing a reliable supplies to meet their demand, and thus, planners and managers in the basin water sectors are faced with the responsibilities of evaluating, conserving, and developing policies for water resources in their concerns. Nile basin encompasses ten states, most of these states are currently facing serious water scarcity conditions.

This paper assesses the river hydrology, geography, and summarizes the history of the basin disputes and treaties over Nile's water. The core concern of the paper is to be concentrated on the alternative supplies through the conservations of the upstream water losses, especial considerations are given to Sudd region losses. Thus forming a guidelines that may immediately balance between supply and demand in the basin, and finally to harmonise states policies for establishing a greener regimes environment that may govern states actions.

098. Sarah Aziz & Mazlin B. Mokhtar, Malaysia

Regulating Water Towards Sustainability in Malaysia: Learning from the Past, Looking to the Future

Water is a resource that not only supports life but is a social and economic good, that has through the course of Malaysian legal history, been subject of much conflict, negotiation and resolution. In Malaysia, the issue of water has been long debated, and was prevalent even before independence in 1957 from the British Empire. In place are laws that go back to 1920, and a place in the Federal Constitution of Malaysia 1957, as a subject matter that falls within both Federal and State government legislative jurisdiction. This in turn has raised much concern as to how water should be managed to ensure its sustainability, and the legal framework and policy objectives post-Independence provides clues as to the direction that the nation is taking.

This paper will discuss in brief the legal history of water, from 1920, and the national policy objectives from 1957 to present, and from this draw lessons that can better facilitate an integrated and holistic approach. It shall also discuss the issues pertaining to "regulating" water, its role as a resource provider; as an element of the ecosystem that sustains life; as a resource with an important ecological function; as an economic good; as a resource of heritage and cultural value; and issues relating to impact of human activities and natural phenomena to water, from pollution to hazards. The challenges facing the development of an integrated approach to regulating water too will be looked at, and possible remedies tabled. The issue of accountability and responsibility and aspects relating to water governance, from institutional capacity, participation and instruments of governance will be explored from the context of how it can strengthen legal instruments and facilitate better compliance and enforcement. Transboundary issues will be briefly touched on to

amplify the great need to ensure that a proper legal framework is instituted so that water, as a resource can be sustained for the generations to come.

044. K. Lenin Babu & R.K. Somashekar, India

Water Management and Changing perceptions in Time and Scale

Water as can be expected has played a very important role in the evolution and prosperity of Indian civilization from time immemorial. The importance was duly recognized by giving the religious sanctity even. India has 14 major river basins. However, with raising population and resultant demands of water for agriculture, for urban centers and industrial requirements has increased the pressure on the water and its harness. Being a monsoonal country with most of the precipitation occurs in 2-3 months in a year has necessitated the need for storage of water and subsequent construction of large reservoirs. In initial stages after its political independence, these large reservoirs were seen as 'Temples of Modern India' and were continued to be developed with both financial and technological assistance from within and outside. The resultant displacement and submergence of forest resources were not given serious thought. However, increasing protests by project affected people against such large reservoirs and failure in the delivery of promised goods, has put speed breaker in the continuation of such large scale projects. The emphasis has shifted to micro water shed management and rain water harvesting etc. These actions are showing good results as well. However, with failure of monsoon in the current year, the political leadership is propagating the idea of linking glacier based northern rivers with rives in south, promising that such a link would solve the India's water problems forever. However, this lacks any scientific study. In this paper, an attempt is made to capture the water management and changing perceptions of community and leaders from the independence.

117. Hassiba Bouabdesselam, M. Bouabdessalm, Algeria

Water in Oran, a management history

Water it is the life, it runs on our planet, in our body. Water formed our ground, decided our evolution, it will also continue to model our society and our culture. Algeria, was Spanish, Turkish and French colonies, up to 1962 it became free country. The first great water law, that of April 8, 1898, intervenes at the end of XIXe century to organize the various water uses which are largely, developed consequently to the industrial revolution.

For the first time, the state intervenes to regulate the uses, by a standard system of authorization "water policies" no one related to "the watery environment" did not exist in these texts. The law 1935 falls under a similar logic, except that at that time "the ancestor " of the classified installations saw the day, with taking care that the industrial development remains compatible with the requirements of public safety. Oran at that time, did not have sufficient water resources, the population could feed only starting from one source, located at Ras el Ain, in the heights of Oran.

It in 1952 that the first dam was built at 200km from Oran, in Tlemcen located at the west of Oran. Then, a second dam was built in the east of Oran to feed the city knowing that the number of population did not cease growing. Underground water is often brackish. In 1964, the first laws appear to regulate the water management with creations of the basin agencies, whose principal objective was to satisfy the public water supply and the public health. Then succeed, other laws with the most important is that 1992 which says in the first article "water forms part of the common inheritance of the nation. Its protection, its development and the development of the usable resource, in the respect of natural balances, are of general interest". The management of water in Algeria, are the responsibility of several actors of water, that they respect the code water. Oran, is a city which suffered a long time from the problem of water shortage, due to the dryness, the outdatedness of the adduction networks, the unconsciousness of the households which are obstinent to waste, the stations of purifications which do not function, the ridiculously low tariff of water. Following this situation, the cuts and rations are the daily practises of water managers. The population had recourse to storages and to purchase of fresh water from the water hawker seller. There is no legislation which regulates this market, more than the quality of the water sold

by the hawker sellers always does not meet the standards of potability. A detailed study was undertaken on the situation of water in Algeria, and particularly in Oran on the regulation and the socio-economic effect of the management of water.

021. Micheline Cariño, Mexico

Water Utilization and Cultural Heritage in Baja California: The Ranchero Efficient Use of Natural Resources

The strategic use of water and soil resources by the bajacalifornian rancheros was based on a cultural syncretism between Californian Indian and Jesuits missionaries' colonial cultures. We can identify two important principles in the use of these resources: the norm of avoiding any kind of waste, and the rational and selective use of the biotic diversity. The rancheros had a successful social reproduction; they manufactured goods for daily consumption and intelligently used the primary materials from the environment without over passing the ecosystem carrying capacity. Other important elements of the rancher culture were the control of the population growth, the concentration in low density groups, and the spreading distribution in the Baja Californian territory in accordance with the productive potential of the environment.

The actual South Baja Californian society would be more rewarded if some of the cultural strategies of the rancheros were practiced again. For instance, a better and more efficient use of local natural resources avoiding the import of new goods or productive activities that increase the dependence from other regions and provoke the unsustainable use of water and soil of this territory. It will also be important to understand that a low quantity and density of the population in Baja California Sur is a requirement for its sustainable development, instead of an obstacle to it. Nevertheless, in the development of the agriculture since the middle of the twenty century we can find many examples proving that the South Baja Californian society is far from the geographic identity that rancheros had in the 18th and 19th centuries. From environmental history, we can learn new ways for renewal of traditional use of water and soil that are much more sustainable than those imported from other regions and cultures.

111. Gobinda Chakraborty, USA

International River Basin Disputes: Exploring a Framework for Cooperation

No doubt, managing international river basins for the common good remains a societal goal today. To achieve this goal, a range of instruments is being adopted: river basin organizations are bringing stakeholders together to internalize the politics of allocation; market mechanisms are widely being used to rationalize the economics of allocation; and legislation is enacted and enforced to ensure the regulation of allocation. These arrangements are to some extent increasing further tensions because of almost total absence of global water regime and relevant compliance mechanisms. However, interestingly enough, international epistemic communities have extensively focused on the conflict patterns and other related issues over shared water basins from the perspective of realism, which is extremely partial and fragmented to explore as well as understand the dynamics of international river basins in terms of theoretical deconstruction. Perhaps, outcomes might be different regarding shared river basins if other paradigms of international relations were applied in a broader framework.

Therefore, the central question of this paper would be: What types of benefits (political, economic or whatever) could potentially be obtained in international river basins using alternative explanatory discourses? To answer this question, this paper will explore the dynamics that drive the choice between conflict and cooperation by providing a framework for examining the extent of potential benefits that could underlie these choices. A common framework would be constructed to categorize different types of potential benefits from cooperative measures based on comparative study with historical insights, using case studies of international river basins chosen from a wide range of political, geographic, economic and cultural conditions. In addition, international river basins such as the Jordan basin in Middle East, the Nile in Africa, the Colorado in North America, and the Ganges in South Asia would be comprehensively testified by the theoretical underpinnings of liberal, neoliberal institutional, constructivist, and domestic politics paradigms in order to support

the proposed common framework. Finally, the paper concludes by saying that identifying and understanding the range of often-interlinked benefits derived from the cooperative management and development of international river basins is central both to better management of international river basins, and to inter-state relations sharing those basins.

158. Rehbieh Suleiman, Remy Courcier & Francois Molle, France, Jordan

Water in the Jordan Rift Valley: Who Gives and Who Receives?

The Jordan Rift Valley is a crucial natural and geo-political artery of the Middle-East. From ancient times to the construction of large-scale irrigation and urban water facilities in the second half of the 20th century, and to the current struggle for water in Jordan, the appropriation of its water has been constantly remodelled and re-ordered. The paper provides a historical retrospective of such transformations, with a focus on the current viewpoints and meanings of its "development" as well as on the allocation of water itself.

089. Pascal Dadjé Paktano, Cameroon

Institutional development analysis of the Lake Chad Basin Commission (LCBC) from 1964 to 2003.

The LCBC was established by a Convention and Statute signed on May 22, 1964 by Cameroon, Chad, Niger and Nigeria, countries which border on Lake Chad. The aims of the Commission are to regulate and control the utilization of water and other natural resources in the basin; to initiate, promote and coordinate natural resources development projects and research within the basin area; to examine complaints; and to promote settlement of disputes, thereby promoting regional cooperation.

The Commission is now facing several challenges. Among them are the territorial dispute between Cameroon and Nigeria in the Darak zone and the drying of the Lake which lost practically 95 percent of its surface area in 30 years. With the present political instability and the weakening of classic social, human and economic activities such as fishery, husbandry, agriculture and trade in the basin, it is important to ask oneself if the LCBC could still be recognized as an efficient organization since institutional weakness usually constitutes a roadblock to development in developing countries specially in Africa.

The first purpose of this paper will be to examine the survival process of the LCBC since 1964. Secondly we will analyse the effects of the current negotiations between Nigeria and Cameroon after the October 10th International Court of Justice Judgment on the LCBC. Thirdly, our objective will be to observe and study the membership enlargement process of the LCBC after 1994, the bargaining process between Chad basin countries and Congo basin governments for the implementation of the Inter-basin Water Transfer Project from river Oubangui to Lake Chad's tributary Chari for the safeguard of the Lake, and the financial Institutions' support to the project.

052. Joseph Dellapenna, USA

The Importance of Getting Names Right, The Myth of Markets for Water

Markets allegedly are ideal institutions for managing water both nationally and internationally. Markets are presented as functioning automatically and nearly painlessly. As a result, they are much in vogue among policy makers today. True markets, however, have seldom existed for water rights and there are good reasons for believing that they seldom will. Water is an ambient resource where the actions of any one user necessarily affect many other users. Thus, if true markets are to be relied on to allocate for particular uses and distribute water among users, the transaction costs of organizing contracts with all holders of water rights (let alone those holding less formal claims affected by a sale or lease) generally have been and will be prohibitive. Water, in short, is the quintessential public good for which markets simply do not work.

This paper explores the nature of markets and the forms of property that have been developed over time for the right to use water, beginning by explaining why water has customarily been treated as a public good. The paper then explains why treating water as common property leads into a tragic over exploitation as soon as water becomes a scarce commodity, and goes on to describe the market failures that are characteristic of treating the right to use water as private property. The paper then explores the California Water Bank, often described as proving that markets for water work, but finding instead regulation masquerading as a market. As Confucius reminds us, if we do not get the names right, we cannot expect affairs to be in order. Finally, the paper presents the "regulated riparian" mode of water management that operates on the basis that water is a form of inherently public property about which basic allocation distribution decisions must be made by public agencies. The paper concludes that various economic incentives, including fees, taxes, and "water banks," have a useful role to play in managing public property, but that true markets must remain a phenomenon marginal to the enterprise of managing large quantities of water for the benefit of numerous users.

028. V. Dukhovny & P. Umarov

The History of Water Resources Management in Central Asia: Past Experience and Future Challenges.

Sharp continental climate of Central Asia has predetermined dependence of peoples, inhabiting this region from times immemorial, on water resources use, management and development. It has been not by chance that from ancient time local traditions, human memory and folk epos in all countries of the region have always focused on water. And what is more, water is in fact the main factor of people's survival under severe climatic conditions of the arid zone. The major way and means of such survival over the all historical time have been communal water use and management. The communal participatory approach had developed certain principles and provisions. Representatives of various groups of local population jointly made decisions on all vital issues of water use and conservation.

Neither water related war, no conflict has ever taken place in the region. Water has always united Central Asian nations.

The former Soviet system abruptly changed centuries old indigenous principles of water resources management. The federal and republican governments had taken all responsibilities for water management, created a ranked, well controlled organization of water supply, allocation and centralized water management hierarchy from top to bottom, which allowed transporting and distributing water through a huge water infrastructure with heavy operational and management costs. Though the system was managed, especially at the inter-farm level, enough efficiently, nevertheless, there were two principal disadvantages: - ignoring opinion of all water users and water demands of nature itself.

At the same time, the Soviet heritage has played a positive role in development of the Central Asian region. Among such positive aspect are: - creation of powerful water management infrastructure, including unique dams, water reservoirs, pumping stations, drainage system equal to foreign analogs; - high level of education and training, science and professional skills of water specialists: - joint work of water specialists under the single sector management in accordance with unified standards and rules of designing, constructing and operating water management complexes; - establishment of basin organizations for conducting hydrological water management on two main rivers of the region.

To date the Central Asian states have created a specific organizational basis for regional cooperation in water sector, which allows, in general, avoiding conflicts on water resources management issues. Modern situation requires immediate change of many basic provisions in regional water resources management approaches and development of water related sectors. It has been brought forth by changes in political and economic situation in the region, which are characterized by significant decrease of economic potential as compared to the period of 1980-1990, and hence, ability of the states to sustain such a complicated water management infrastructure at the expense of own funding. Another significant disadvantage is a growing tendency for giving priority to local and group interests in water resources management, which gives consideration neither to administrative borders, nor to command methods of guidance. To some extent, water resources management remained to be a semi-closed system, though bearing

in mind that well being of millions of people depends on the results of its performance, this system should be transparent and accountable to the society.

051. Maurits Ertsen, The Netherlands

The Gezira Irrigation Scheme in the Sudan in the Context of Colonial Irrigation Development in Africa

Colonial irrigation in Africa has been developed in the context of colonial policies like "white man's burden" and "mission civilisatrice". At the same time, colonial irrigation efforts were aimed at economic development, a shift from mere exploitation to a policy of productive imperialism. For the two most important colonial irrigation projects in Africa (in terms of command area planned), the British Gezira Scheme (the Sudan) and the French Office du Niger Scheme (Mali), the potential to grow cotton was an important stimulus to start the systems. The Gezira scheme in the Sudan appears to be the spider in a web of colonial irrigation relations. It has been developed by British engineers with experiences from India and Egypt, it has served as point of reference for French irrigation activities in the Niger Delta and it has shaped ideas for the Mwea system in Kenya. On its turn, when plans were developed in the 1970's to construct irrigation schemes in Kano, Nigeria, Mwea served as the foremost example. When looking at British colonial irrigations efforts in other African regions than Egypt, the irrigation efforts can be best characterised as imposed production regimes. Similar characteristics can be attached to the irrigation activities of the French in West and North Africa. Shared properties are the factory-like organization of the schemes and the prescriptions of colonial management to structure the activities of the farming communities in the schemes. The factory resemblance is also reflected in the mathematical layout of the systems: canals are straight and plots are square. This production regime appears to be in contrast with colonial irrigation developments in the Indian colonies of both British and Dutch.

Colonial powers in British India and Egypt had to rely much more upon native staff within the canal bureaucracy, over which supervision was minimal. The circumstances within which the Dutch engineers and others involved formulated their policies and developed their irrigation approaches in former Indonesia are very similar to those in British India, not only because of the relative dependence upon local authorities and farmers, but also with regard to important issues at stake in irrigation development: the role of famines, debates on financial returns and the consequences of technical problems. Of course the supposed distinction is not absolute. The French, who probably have developed the most factory-like irrigation technology with its straight, concrete, standardised canal grids in Northern Africa, did have considerable trouble to let the local farmers adapt to French colonial efforts. Local farmers might have had no influence on the design of the Office du Niger, they certainly did influence the success of the system by not showing up when obliged. The other way around, in the East Indies the Dutch developed several rather strict, production regime type, management systems. Nevertheless, irrigation development in both Egypt and the British and Netherlands Indies, contained itself mostly to water management and did not attempt to manage the whole production process as was attempted in most colonial irrigation systems in Africa.

036. Eran Feitelson & Itay Fischhendler, Israel

The Short- and Long-Term Ramifications of Linkages Involving Natural Resources: The U.S.-Mexico Transboundary Water Case

Issue linkage is often recommended as a strategy to enhance cooperation. Lately it has been suggested that this strategy could also be applied to the management of transboundary natural resources. The present study examines the viability of this suggestion. It argues that in the case of natural resources such a linkage may have both short and long-term implications due to the locality and longevity of the issues involved. The study focuses on the negotiation process over the U.S.-Mexico transboundary water and on the current conflict around the Mexican water debt to the U.S. along the Rio Grande. The negotiation was based on a long-term spatial linkage between the water of the Colorado River and those of the Rio Grande. This spatial linkage was advanced by a short-term issue linkage, in which the Mexico supported the establishment the United Nations in return for the U.S Federal Government's willingness to accept the long-term spatial linkage. These linkages were found to have adverse implications both in the short and long term.

The adverse short term implications include delays in negotiations, inconsistency with the legal doctrines held by the different parties during the negotiation and a threat to sovereignty. The

adverse long-term implications include the inability of Mexico to maintain the linkage during the current drought along the Rio Grande along with its limited leeway to renegotiate the treaty in order to adapt the linkage to new hydrological conditions. This advance Mexico to seek other mechanisms to enables it to meet its water deliveries to the U.S. along the Rio Grande as stipulated by the treaty. These finding suggest that it is vital to include tools that might mitigate these adverse effects in any cooperative agreement.

126A. Eva Jakobsson, Sweden

Ditch Politics. Building drainage systems in Sweden, from the Middle Ages to mid 1800 's.

This proposal is a part of a larger individual project, "Water Struggles. Swedish water history form the Middle Ages to early 20th century", financed by the Swedish Research Council.

In this paper I will focus on the build up of drainage systems. Drainage of fields and wetlands as well as lowering of lakes was part of the struggle to reclaim and gain arable land in Sweden for hundred of years. Until today 2,5 % of all the lakes in Sweden have been. It is estimated that 40 000 drainage projects have been carried out in Sweden.

When man interferes in water system one could name them water infrastructures. These infrastructures are stretching out and binding together the water flow through the landscape to an ever increasing extent. Water infrastructures are erected to keep up activities like for example irrigation, drainage, reclamation of wetlands, lowering and reclaiming lakes, forest drainage, log driving and hydropower development. It is worth noticing that these observations are valid both for areas with abundant water as well as arid regions. Theoretically there is no difference between the build up of a hydropower system or constructing a drainage or irrigation system.

These water infrastructures have an integrated duality. They are both a part of the hydrological cycle at the same time they are controlled by man. Their complexity consists on one side of a melting together of the non-human and the human in the water infrastructure and on the other side that several demands on the water have to coexist in the system. As these infrastructures are linked to the water circulation, they depend on and compete with each other.

To uphold these infrastructures it is not only the hard work of peasants and technological knowledge that have to be present. These drainage systems are also built of and upheld by social institutions. Beside the artefacts, we also have to study for example property rights, standardisation processes (like depth and with of a ditch), expropriation rights and so on. However, as we are discussing water, we have to consider the always present up- and down streams conflicts. For example, does a downstream landowner have an obligation to be part of a drainage system even if his land does not take advantage of the new ditches? Another circumstance influencing the social institutions is changes in agricultural technique, as for example the introduction of under-drainage in the middle of the 19th century.

From the first straightforward regulations of the mediaeval legislation a complicated system of drainage laws was developed over 500 years. It was not until 1879 that Sweden passed a legislation replacing the patchwork of old drainage laws and by that contributing to making the Swedish landscape less wet, but also less diverse.

126B. Eva Jakobsson, Sweden

Understanding Lake Vänern. Perspectives on Europes Third Largest Lake, 1600- 1900.

With its water surface of 5650 km² Lake Vänern is Europe's third largest and Sweden's largest lake. Lake Vänern has not yet had its history written. Perhaps this could be explained by the fact that historians find it unfamiliar to define a lake as an object for historical research - to discuss water bodies (rivers, aquifers, wetlands) as research objects. In a water history perspective lake Vänern is a physical, a mental as well as a social construction changing over time.

A lake could be described as a risk on one side, and at another as a resource. As risk themes one could mention shipwreck losses, floods and the lake as a recipient for towns and industries in the drainage basin. As a recourse Lake Vänern has for hundreds of years been a place for domestic as well as commercial fishing. The lake has also been very important for navigation. During the 1900`s Lake Vänern became important for water supply, as a recreation lake (20 000 islands!) and as a reservoir for hydropower industry.

Beside these perspectives there is a further perspective - the scientific - which I will focus on in my paper. The paper derives from a larger project on the hydrological science history of Sweden that I have been working on for a couple of years.

The scientific topic longest discussed in connection to Lake Vänern is the question of the apparent, but unpredictable water-stage fluctuations (the lake can raise for a couple of years until it falls under some years). Over time different explanations, like an underground tunnel connecting to a Swiss lake, have been presented to explain these fluctuations. However, the key concept to make a solution of the dilemma was to place and define the lake in its drainage basin. The solution was the understanding and definition of the lakes comprehensive drainage basin, stretching out and into the Norwegian mountains. By its diffusion it contains different types of drainage regimes, making the water level fluctuation unpredictable. The interest for these water stage fluctuations, that have troubled riparians and navigation interest, has given us one of the oldest continuous series of water level measurements reaching back to 1807.

To find a solution of the flood problem scientist and engineers have discussed how to take control of the lake. Since 16th century a series of proposals with the purpose of lowering Lake Vänern or taking control of the outlet has been presented. The problem has still not found its answer. As late as last year, after some years of flooding during the 1990`s, a tunnel from Lake Vänern to the sea was proposed.

127. B.Mintesinot, W. Kifle & T. Leulseged

Harnessing the water resource potential of the Tekeze basin: achievements, challenges and prospects.

This paper addresses the major issues related to water resource development and management in the Tekeze basin (which is part of the Nile basin), with implications to sustainable water management in the fragile environments of northern Ethiopia. The Tekeze basin is generally represented by high variability (spatial and temporal) of rainfall, resulting in chronic food insecurity. Moreover, water levels in wells are getting very sensitive to the rainfall variability. Geohydrologically, most of the aquifers in the basin are characterized by shallow unconfined types, with thickness up to 50 meters.

In the last years, the Ethiopian government has been undertaking a number of activities such as construction of micro-dams, ponds, diversions and other surface water harvesting schemes in the Tekeze basin. In areas where there has been intensive surface water harvesting activities, a number of positive trends are recorded, such as an increase in the discharge of springs and recharge of groundwater systems, and an improvement in the quality of spring and groundwater. Moreover, there is an improvement in the food security of the local farmers as well as water supply for livestock and domestic consumption. The micro-climate and vegetation systems are also found to improve in those areas where water harvesting activities are in place. The regional implication of this intervention is increasing base flow, improving the macro-climate, and enhancing the water security for livestock and domestic consumptions. Though a number of positive trends are recorded, there are challenges to the present water development practices in the basin, including siltation/sedimentation of the reservoirs, improper use and management of irrigation water, and salinity problems. For sustainable water development and management in the Tekeze basin and in other areas of the northern Ethiopia it is advisable to employ the conjunctive use of water development, apply proper sedimentation /siltation hazard assessment and mitigation measures, and address the problems related to salinity and irrigation water management.

128. Alaba Boluwade, Nigeria

Modelling Niger River Flow For Sustainable Rural Development.

This paper reports the modeling of Niger River flow using the timeconsuming and complex statistical model based on the Box-Jenkins Methodology using the Autoregressive Integrated Moving Average (ARIMA) to model Niger River flow on time domain.

Average monthly discharges from 1984 to 1995 were used for the model development, while that from 1996 to 1997 (24 months) were used to test the effectiveness and how adequate the model is. Two models were entertained. The first entertained model did show evidence of randomness about zero; while the second model did not and was therefore dropped. When Portmanteau lack of fit test was performed on the first entertained model, it shows adequacy. In the forecasting analysis using this model, the average percentage error for 1996 was 1.45% while that of 1997 was 1.38%, which indicated that the model entertained could be said to be adequate. Potentials of the Niger River flow could then be realized in terms of hydroelectric generation, irrigation practice and community water supply.

Keywords: Box-Jenkins methodology; Niger River flow; average monthly discharge; Portmanteau test; average percentage error.

129. Kaushik Gosh, India

Overflow Drainage Basin Management in Bengal: A Historical Perspective

Water resource management and irrigation has been the oldest applied sciences in the world whose centers were the oldest civilizations. Healthy irrigation itself was a great school of civilization where men worked together in harmony breeding health. Some 6000 years ago the Egyptians introduced their system of basin irrigation into the Nile Valley by digging canals which in use today, and leading the turbid waters of the Nile into the embanked basins. Contemporaneously with them, the Babylonians began their system of perennial irrigation in the joint delta of the Euphrates and Tigris.

The system of drainage basin management by overflow irrigation was evolved by the rulers of ancient Bengal some 3,000 years ago. West Bengal is a small state in Eastern India; its landscape crisscrossed by innumerable streams and rivers. It enjoys a maximum rainfall of from 50 to 60 inches. However, Bengal often suffered from the vagaries of nature like devastating floods and droughts. Instead of trying to master nature, the ancients chose to adjust their ways to the physical environment. These methods are the accumulated wisdom of a predominantly agricultural community whose farming practices were very simple and technological application was optimal.

Full use was made of the:

Rich waters of the Ganges river and Damodar river floods, and
The abundant of the monsoon rainfall.

Drainage basin management was done by digging canals which controlled the basin overflow and ensuring regular water flow to the fields. Overflow canals of Bengal worked under different conditions. Irrigation of the country was principally done by rainfall and the river water was used to manure the rainfall, and kill the mosquitoes or deprive them of their malignity.

The role of the farmer was simplified to cultivating the suitable crops at the right time. Their cropping pattern, like the cultivation of rabi or kharif crops was also developed keeping the variation in seasonal availability of water in view. Plots of land were classified according to their ability to retain moisture or accessibility to water. A little ingenuity was enough to meet their needs of irrigation in times of relative scarcity or to irrigate lands which were away from rivers. It was what today's experts call water harvesting by ponding.

The ancients by increasing the supplies of muddy water, steadily improved the lands as time went on, and also decreased the danger of an inundation. The minimum supply for healthy rice irrigation is one cubic foot per second for 70 acres. Any extra water above this, as time goes on, is an improvement.

Drainage basin management through overflow canals irrigated an area of almost 7,000,000 acres in Bengal. After seeing the results of seventy years of abandonment it is quite imperative that there is nothing before the country but to return to it.

This method of overflow drainage basin management is not only adapted to Bengal but to all countries similarly conditioned.

130. Elizabeth Bishop, USA/Egypt

Vision and Measure: Statistics and Public Authority in the Nile Valley

Nineteenth-century Egypt's Irrigation Authority's employees speak of the modernist structures Britain imposed on administration of the Nile valley. Irrigation's importance to nineteenth century Egypt can be compared with space research in the twentieth century as a leading application of technological research to politicized claims of cultural superiority. This paper considers statistical techniques' practical applications, datagathering and the quantification of random events by Anglo-Indian irrigation engineers, as documented in Department of Irrigation publications.

Anglo-Indian irrigation engineers published their claims to unite colonial and technical authority within their enunciative function in Egypt's government. This paper argues that Anglo-Indian irrigation engineers were not removed from discourses of power: on the contrary, they actively developed claims for colonialist political domination by means of numerical domination, which they recognized began at the same point in time. Anglo-Indian engineers claimed authority over the Nile, based on perceptions superior to those of Egyptian engineers, in part advancing refined understandings of natural processes developed and replicated in statistical models.

This paper reconstructs positions of dominance for Egyptians vis à vis the Nile, as well as with regard to Anglo-Indian advisors. The 1919 Milner Commission report identified new responsibilities for native-Arabic speaking engineers in the Ministry of Irrigation. Building on the strengths of Donald Reid's "Educational and career choices of Egyptian students, 1882-1922" (IJMES, 8, 3, 1977), which inadvertently valorizes legal training by emphasis on parliamentary Egypt's public life, this contribution considers the development of national educational institutions, as well as the participation of native Egyptian engineers in European knowledge projects, indexed by the science of statistics' development. This paper concludes by considering the 1927 International Statistical Congress, organized under the League of Nation's auspices, as a moment during which Arabic-speaking technicians sought to claim their position as heirs to 'modern' statistical knowledge.

131 Youngjin Kim & Moo Young Han, S. Korea

Korean traditional technologies of rainwater utilization and rainfall measurement

Being agriculture based society, Korea has so advanced and scientific tradition of rainwater utilization. From about A.D 300, Korea has built a lot of rainwater reservoirs. Especially, during Joseon-dynasty that is from 1392 to 1910, Korea promoted remarkable technical achievements in various fields of rainwater utilization. Rainwater management was so important responsibility of Korean rulers that can control their governmental power.

Most of all, Korea is the 1st nation that produce and use a precision rain gauge. Upon the order of the Great King Sejong, Youngsil Jang invented the first rainwater gauge system in 1441, which is 200 years earlier than the European gauge of B. Castelli. The system is composed with rainwater gauge named Chuk-u-gi, its stone housing named Chuk-u-dae, and a ruler named Joo-chok. The original type of the rain gauge was made from only iron, but after that new types of copper or ceramic were manufactured. A new act was legislated for the rainfall observation by Chuk-u-gi in May A.D. 1442. According to the act, the recorded rainfall data from local governments can be collected through nationwide network. Korea started regular rainfall measurement from A.D. 1777, and she has the longest periodic rainfall record in the world. Seoul rainfall was measured until 1907 with a rain gauge of this type.

Koreans tried to treat and use rainwater scientifically, SeongSoBuBuGo, an anthology written by Kyun Huh at A.D. 1611, says that many Koreans put charcoal into rainwater jars and the stored rainwater can be used during very long time without decay of its quality. That is to say, Koreans treated rainwater with activated carbon at least in 400 years ago. When used for medicine, precipitation water that are rainfall, dewdrops, etc, has been classified into 9 categories according

to its characteristics and intended use, which can be found in Dong-Ui-Bo-Gam, a Korean medical encyclopedia written by Jun Huh, a royal medical doctor in A.D. 1613.

Rainwater harvesting is becoming a new solution of water augmentation for sustainable development. Many nations that have similar meteorological conditions with Korea stored and used precipitation traditionally as their water source. However, Koreans did not only use rain but also developed their own unique technology and science of rainwater. Currently, many Korean experts review their time-honored technologies and try to promote and advance them through international corporation.

132. Bernard Barraque, France

Beyond State hydraulics and water markets: European water a common property?

Having studied water policies in the European Union's member States, in a comparative and historic manner, I tend to think that the European experience has been overlooked in the debate on water and globalisation. To summarise, water resources issues seem to be easier tackled in the old continent than for instance in Western U.S. because we have never let water become a good to own, be it by private owners or by governments. Allocation of water resources is based on usership principles and is increasingly done by users' communities under the guardianship of governments; this increases flexibility in allocation rules, and helps abandon former policies based on supply side and large hydraulic projects. Besides, it offers a major point of application of the UN 1997 Convention proposing the concept of reasonable and equitable use of international waters, in a subsidiary manner. But, in southern Europe as in many developing countries, this growing acception of European water as a common property subject to flexible allocations is not well embedded in the water culture. This is the reason why it is so important to study the history of the three categories of water in Roman law (*res publica*, *res nullius*, *res comunis omnium*), and to see how, in accordance with the *Volksrecht* and the Germanic customary law, the third category is gaining momentum since the second World War, while the dream of Napoleonic Civil Code was to suppress it. Paradoxically, it brings back on the scene features and institutions, which were more common in the middleages. This will be illustrated among others through the biosketch of Benjamin Nadault de Buffon (1804-1880), member of the French Corps of Engineers, founder of the hydraulic service in the ministry of public works, but also good lawyer and keen on community irrigation systems.

133. P.S. Navaraja & S.G. Lecturer

Environmental and Social Conflicts of Aquaculture in Tamilnadu

The damage wrought by aquaculture to the surrounding ecosystem has led to serious socio-economic and environmental conflicts in coastal Tamilnadu. If the interdependence between the ecosystem and industry is not recognized, aquaculture will be limited by the impacts of its actions on the environment. This paper focuses on the environmental and social conflicts of aquaculture in Tamilnadu, which was confirmed by environmental analysis of soil and water samples collected from the problematic areas at varying distances (1-5 kms.) The paper discusses the impact on water quality, coastal ecosystem, surface water and groundwater. Further, it discusses the various types of social conflicts arising due to aquaculture, and stresses the need to implement fiscal and market-based instruments to promote an eco-friendly industry for sustainable development.

Keywords: aquaculture, environmental and social conflicts, coastal ecosystem, water quality, surface water, ground water.

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Key words: aquaculture, environmental and social conflicts, coastal ecosystem, water quality, surface water, ground water.

134. Burkhard Vogt, Germany/Yemen

Recent research of the German Institute of Archaeology at the Great Dam of Marib, Yemen
The Great Dam at Marib, Republic of Yemen, is one of the best known hydraulic monuments in antiquity. It appears that everything has been said but a first season of consolidation in 2002 provided unexpected and completely new insights into the history and the operational principles of the monument. Work was carried out by the Commission for General and Comparative Archaeology, Bonn, of the German Institute of Archaeology. It enabled for the first time a large-scale excavation of major architectural and functional components of the dam mainly at the so-called Northern Sluice and to a lesser extent at the earthen dam and the Southern Sluice. Evidence from excavation and new epigraphic finds suggests that at least the Northern Sluice in its present shape was constructed only during late Pre-Islamic times.

135. Abdul Sattar Kahdim, Alla Abdulrazaq Jassim & Saleh Ismail, Iraq

Influence of recovery and temperature for various membranes on the quality and quantity of RO systems

The aim of the present work was to study the effect of recovery and temperature on the quality and quantity of reverse osmosis (RO) systems for two types of membranes. The study was conducted in a pilot plant at the university of Basrah, College of engineering which has a capacity of 9m³/h. The pilot plant has two types of membranes vies Saehane, type RE8040BE of Korean origin and TFC-Koch system membranes model 8822-XR of USA origin. Also, the pilot plant uses brackish water from the Tigris River with TDS<600ppm. It found over 270days of continuous operation, the quality and quantity of Saehane membranes are very sensitive to values of recoveries than Koch membranes but was excepted from practical point of view. I was also observed that the properties of output membranes various with feed water temperature for both types of membranes.

Key word: reverse osmosis desalination, performance, recovery, temperature

136. Florian Ruhland, Germany

Little Venices in pipes: Water and environment in pre-industrial cities in Central Europe and what we can learn from it

This paper deals with water supply and sewerage as a part of the environment of pre-industrial european cities in the perspective of historical geography. The starting-point is the attempt to reconstruct (and deconstruct) the urban environment in Central Europe before the 19th century, about which our knowledge is quite poor. A lot of long-established myths, images and prejudices exist about the pre-industrial urban environment and about the way citizens dealt with it in the middle ages and early modern times. But they are not appropriate, because it seems that quite a lot of them are perceptions made up in the environmental crisis of industrializing cities in the 19th century, when modern centralised water supply and sewerage systems were introduced.

The results of a lot of disciplines and sub-disciplines must be taken into account, which represent plenty of approaches to the city and its environment. They range from urban ecology, urban geography, urban (environmental) history, urban archaeology to urban engineering. But as urban ecology has been able to just develop partial models even of contemporary cities, historical investigation can't be holistic, but must be rather reduced to a core.

Water in the urban sphere is investigated in this paper under the main question, how the infrastructure of water supply and sewerage changed the "natural" urban environment and the urban cultural landscape, and why this infrastructure was shaped the way it was. Case studies are the cities of Prague and Nuremberg. An elaborated system of water supply with wells and pipes, in which water was pumped from rivers or the ground, developed from the late middle ages down to the early 19th century. These early water works and the connected networks of pipes can be described as "proto systems", a term introduced by Martin Melosi for early 19th century America. Very instructive and by then not exhausted sources of information about the pre-industrial urban water networks are plans from the 17th and 18th century as well as municipal books of pipes (in Nuremberg: "Röhrenmeisterbücher") and municipal books of wells (in Nuremberg: "Brunnenbücher"), which exist since the 15th century. These sources show, how the networks were

adapted both to the local topographical and hydrographical conditions and the economical requirements. Taking into account the smaller surface areas of pre-industrial cities compared to the cities of today the length of the networks is impressive. Following André Guillerme who has stated that pre-industrial cities in northern France looked like "little Venices", a lot of cities in Central Europe could be described as "little Venices in pipes". A future perspective is to compare more cities than Prague and Nuremberg with the technology of a GIS.

Realizing a crisis of current centralised water supply and sewerage systems even in humid regions of the world one could think about a reconsideration of some characteristics which contributed to the stabilisation of the pre-industrial use of water in cities without neglecting its limits and disadvantages. This didactic aspect of water in pre-industrial cities could be important with the current plans of rebuilding urban infrastructure in western societies and with the building of urban infrastructure in less developed countries.

137. James D. Birkett, USA

Advances in Seawater Desalination, 1800 –1900

During the 19th century seawater desalination progressed from being a highly energy inefficient curiosity to becoming far more efficient articles of commerce, manufactured in several countries to established designs and employing several distinct technologies. Progress was largely driven by market-pull rather than technology-push, although it also benefited by technological developments in other industries. This paper will touch upon:

- § Advances in technology
 - o Multi-effect evaporation
 - o Mechanical vapor compression
 - o Thermal vapor compression
 - o The use of solar energy
- § Parallel and relevant advances in pure and applied sciences
 - o Properties of water
 - o Properties of steam
 - o Thermodynamics
- § Applications
 - o Marine
 - o Land-based
- § Florida
- § Chile
- § Malta
- § Aden
- § Etc.
- §Manufacturers
 - o England
 - o Scotland
 - o France
 - o Germany
 - o USA

At the end of this period, desalination equipment in a range of sizes could be purchased from a number of suppliers. It would however be another 75 years before reliability and operating economics improved sufficiently for it to achieve widespread applicability.

138. E.S. Mohochi, Kenya

The Search for, Storage and Management of Water and Its Implications on Women 's Welfare Among the Kuria of East Africa: A Historical Perspective.

The Kuria, an African community in Kenya and Tanzania in East Africa, is one that holds to its traditions quite dearly. For instance, contrary to current thinking in most of the world, female genital mutilation is still widely practiced. Gender based role differentiation is one other cultural practice that is still strictly adhered to. This is despite the long time cross-cultural interaction that the Kuria have had with other communities and the rather modest gains made in education by members of the community. The bigger problem, however, is the fact that the distribution of roles is heavily imbalanced in favour of men. Consequently, efforts made by women to uplift their standards of living, in essence society 's living standards have been greatly impeded by the numerous tasks that they have to contend with on daily basis.

This paper will investigate the predicament of Kuria peasant women with specific emphasis on the water question. A historical analysis of the situation will be attempted. Using the Kuria case, it will be interesting to establish whether, 43 years after independence, enough has been done to alleviate the burden that has to be endured by women in making water, a very important resource, available to the family. Do women still have to walk long distances in search of water; a practice that greatly affects the participation and attainment of the girl-child in education? Are there positive changes in terms of availability and quality of water? What steps should we take to better the current situation?

139. M. Shirani & M. Shahvali, Iran

Study of Native Waterharvesting Construction Sustainability (Abanbar) in Larestan District of Iran. The most important factor for sustainable development is access to rich water resources. In Iran, low rainfall and its irrelative dispersion cause catastrophe each year: famine and flood. In such conditions, provision of water for present and future generation is vital. According to this fact, the Iranian, have invented various methods to provide water to challenge the above mentioned catastrophes for centuries. For example, in southern part of Iran, the people of Larestan district in Fars province (Iran) have overcome water deficiency and brackish by Abanbars. Abanbar is a water harvesting construction that is widely used for more than 4000 years in Iran. However, there is still a question: Are Abanbars sustainable enough for people activities in long term? This study used sustainability approach to answer this question.

In this approach water resources, which are sustainable environmentally and economically and provide sustainable social conditions for people, are sustainable. The general objective of this study was testing the above hypothesis about Abanbar. This test was conducted by survey method. Ninety-seven Abanbar users were selected by classified random sampling technique and they were interviewed by open and closed-ended questionnaire. The questionnaire was qualified by face validity and reliability tests.

The results indicate that Abanbars are sustainable "socially", "economically" and "environmentally" and their sustainability is according to special culture in the district. To access sustainable water resources in future the study suggests paying more attention to native waterharvesting methods to remove water deficiency problem. To work more for reviving, optimization, repair and protection of Abanbars in such a manner that result in better water quality. To prepare a technical manual based on the results from this research and other experiences to help people how to establish, maintain and use Abanbars in more sustainable manner.

140. Sylvie Paquerot, France

Historical Rupture and Inversion of Values: Recent Evolution of the International Law of Water History is also the recent history, and in the linkage between law, policy and economy, the 20th century had experienced significant ruptures. Starting from a thesis in international law recently finished, I propose to illustrate the evolution of the statute of water in the field of international law, and to analyze the incidence of this evolution on the national level, in legal, political and economic fields.

Is it today conceivable to consider a statute universally recognized for the world water resources? Historically, the only one which has been attached to them in international law is that of natural resource, subject to the principles of sovereignty of States and freedom of exchanges, thus letting operate the specificity of the various national regimes in policy, law and economy.

However, the evolution of commercial and economic international law would tend to let it think which, for the first time in history, empirically, seems to occupy the dominant and universal position. This is operating an inversion compared to the evolution of the legal systems where the standards of law and order tend to occupy the dominant position through, in particular, their increasingly widespread constitutional character. This hierarchical inversion in fact at the international level does not seem however compatible with many systems of national law where the standards of law and order continue to operate, whatever the culture to which they are attached.

We will illustrate many paradoxes, which characterize the evolution of the last decades in order to evaluate not only the power of the model suggested, but also its degree of legitimacy, since the perennality of a model depends on this legitimacy.

Is the global capitalist market framework suitable and compatible with every culture? Can it be used as a framework universally applicable to the water resources? We submit that this form of universalization is neither possible, nor desirable insofar as in parallel, the 20th century also had invented other standards of universalization, of which, those of human rights, which are much more likely to be agreed upon in different national systems of cultural and political values.

141. Robert Kabumbuli, Uganda

Conflict Dynamics in Water Management: A View from Kampala's Wetland Slums.

Background:

A doctoral study in Makerere University investigates how the dynamics of conflict are influencing, and how they can influence, the management of the wetlands to reduce water contamination. The wetlands in the catchment of Lake Victoria's Murchison Bay are the case study. It is based on the understanding that wetlands should filter the water that drains into the Bay from Kampala City, and on the concern that the Bay is the main source of water for the city. These wetlands have been encroached upon and are under real threat from human activity.

For this presentation, emphasis is laid on the impacts of slum settlements in and on the fringes of the wetland system that is also home to the Nakivubo Channel. This channel forms the main drainage system flowing southeast of the city into Lake Victoria.

Objectives:

The study solicits the views of the poor slum dwellers that are in the closest touch with the wetlands, and whose lives are influenced by the wetlands on a daily basis. What are their views on (a) the importance of wetlands (b) whether and how wetlands should be protected (c) the relevance of the law on wetlands. How do their views conflict with official policy on wetlands, and with what implications for Kampala's water system?

Methods:

Qualitative and quantitative methods have been used; 250 questionnaires were administered in three slum communities to households selected because (a) they are resident (b) own property (c) practice agriculture (d) practice brick-making in the wetland. In-depth interviews and focus group discussions have been held. Interviews were also held with policy agencies and NGOs.

Results:

Preliminary data analysis shows that although people know about the law on wetlands, they continue to encroach on wetlands because of mainly poverty. Their views on wetland protection are influenced by their intimate and dependency relationship with the wetlands. Conflicts are many among the communities because of (a) poor or absence of sanitary facilities, the biggest source of water contamination (b) uncontrolled disposal of garbage within and from outside of the community (c) constant floods which destroy property and endanger life (d) lack of well-defined ownership rights over land.

Conclusion:

Conflict of perception, interests and rights over wetlands between the various stakeholders has functional implications for the management of water. An understanding of the nature and sources of such conflict will contribute to the formulation of policy on water.

142. Simo Laakkonen & Sari Laurila, Finland

A river divided? Science and media.

Most people acknowledge the role of science in defining environmental problems. On the other hand the role of media is important in addressing environmental problems for politicians and the great public. There seems to exist a natural link between these two spheres of society. In reality these two elements phenomena seem, however, to be rather distant from each other, if not apart. The paper aims to study how scientists and their work on water problems were considered by media. The study will focus on the Baltic Sea region and cover the 20th century.

Simo Laakkonen has PhD in environmental history. He works currently as a senior lecturer of environmental politics at the University of Helsinki. He has published several books and articles on environmental history. His work focuses on the history of environmental mediation.

MSc Sari Laurila is a hydrobiologist from the University of Helsinki. She has studied the history of scientific studies on water problems in Helsinki and in the Northern Baltic Sea region. She works currently as a researcher in a project supervised by Simo Laakkonen on the environmental history of the Baltic Sea funded by the Academy of Finland.

Results of this and previous projects may be seen in the following address:
www.valt.helsinki.fi/projects/enviro

143. Jala Makhzoumi and Mohamed Ragy Darwish, Lebanon

Water Narratives for the Yammouneh Region: Water Resources and Local Distinctiveness as a Foundation for Eco-tourism.

The Yammouneh region, approximately 320 Km² in area, occupies the eastern aspect of Mount Lebanon. Water, and the characteristically hilly terrain accounts for the diverse and beautiful rural landscape and is inextricably woven into the ancient and more recent history of the region. Water features include historic Roman baths (Yammouneh village), Roman wells, natural springs (Uyun Kirkosh), newly established reservoirs (Barqa), water distribution networks to transport water from the higher elevations to the villages (Mshatiya), a water tunnel excavated during the French Mandate and a water channel linking the lake of Yammouneh to the village of Shleifa.

The production of illicit crops, which was the main preoccupation of the farmer at Yammouneh, ensured high economic return. Government ban on planting these crops in 1992 resulted in severe income reduction and economic losses to the local community. In the decade since, several projects, Yammouneh Irrigation Rehabilitation Project, Yammouneh Economic and Agricultural Sustainability funded by USAID, targeted the region with the objective of increasing the agricultural potential and overcoming the economic adversity of the local communities. However, a predominantly arid climate, the diverse topography, altitudes range from 1000-2900 meters above sea level of the region, years of civil war and communities that are socially marginalized have hindered the utilization of the agricultural potential of the region.

Nature, ecological and agricultural tourism were proposed as sustainable alternatives for development. The concept of tourism is more readily accepted by the local community and as such, likely to succeed. The present paper proposes an innovative methodological framework for documenting the history of water in the Yammouneh (literary survey, folk history, interviews with the locals, visual surveys), using the documentation as a basis for building landscape distinctiveness. The water articulated landscape of the Yammouneh with its historical, vernacular and folk culture forms the basis in planning for sustainable tourism.

144. David Breen, Canada

Private versus Public Water Rights: The Foundation of Water Law in the Canadian Prairie West.

The Canadian prairies comprise a vast region within the North American interior almost as large as France and Germany combined. Much of this region is semi arid and prone to extended cycles of drought. Currently in the midst of such a cycle, the renewed exodus of farmers and ranchers from the region underlines the precarious nature of agricultural endeavour in the region. Those struggling to remain, like their drought besieged forbearers, have appealed for massive government assistance. Both the nature of their appeal and the pattern of proposed assistance are framed by an extended public debate and body of legislation that was initiated in the midst of a similar just over a hundred years previous. This earlier debate centered upon the question of private versus public water rights. The seminal product of this debate was the decision to abandon the doctrine of riparian rights (an important article of Canada's inherited corpus of British common law) in favour of public ownership of all surface water in the Canadian Prairie west and northern territories. This remarkable decision introduced a new and progressive approach to water

management unique to North American experience that was much admired by contemporary American observers such as Elwood Mead. It was a decision that had far reaching and lasting implications.

My proposed paper will examine this precedent setting debate concerning private versus public water, the economic and political environment in which it occurred as well as the particular and vital role played by one man - the visionary champion of public water, William Pearce. (A comprehensive evaluation of existing North American water law, as well as the laws and traditions governing irrigation practice in India, Egypt and Australia, led Pearce to conclude that effective and equitable water management had to be based on the principle that " water is the property of the public." Eventually able to persuade the Canadian Parliament to accept his notion that the government should hold title to all surface water in the prairie region, Pearce saw his principle of public ownership of water enshrined in the North West Irrigation Act of 1894) This paper will examine the intellectual and technical environment which informed Pearce's ideas and which were embodied in the North West Irrigation Act. In its abolishment of riparian rights, the Statute marked a fundamental turning point in law and since it remains the foundation of contemporary water management in the region its impact was far reaching and lasting. This paper will reflect upon these implications, including the statute's impact upon aboriginal water rights.

145. D.L.O. Mendis, Sri Lanka

Ancient Water and Soil Conservation Ecosystems of Sri Lanka.

The ancient water and soil conservation ecosystems of Sri Lanka are better known as ancient irrigation systems (Brohier, 1934). Irrigation is only one of their functions, although arguably the most important one. Other functions include flood control, drainage, soil conservation, and conservation of fauna and flora after the introduction of Buddhism in the 3rd century BC. The term water and soil conservation ecosystems is therefore a more appropriate description.

Thomas Tredgold's definition of Civil engineering as "the art of harnessing the great sources of power in nature for the use and convenience of man", has been incorporated in the charter of the Institution of Civil Engineers, London. This conforms to the concept of dominating nature as against the concept of adapting to nature. The latter may be further subdivided into two categories, namely active adaptation, and passive adaptation.

The ancient water and soil conservation ecosystems of Sri Lanka are a classic example of man's active adaptation to nature. They consist of river diversion systems and storage systems, themselves consisting of small, medium and large reservoirs. These systems had been constructed over a long period of time, beginning in about the mid first millenium BC. There are three important aspects of these systems that merit study, namely

- their evolution and development over a long period of time
- their stability and sustainability over an even longer period
- their final apparently irreversible decline after about the 12th century

Recently, a Water Heritage Foundation has been started in Sri Lanka, one objective of which is to study the above aspects of the ancient systems. A book titled Water Heritage of Sri Lanka was published in December 2002 by this author, who has done research on the subject for many years including at the Needham Research Institute, Cambridge, England, under the late Dr Joseph Needham.

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146. Eric Gilli, France

Role of the karstic systems in the definition of the underground alambic model in antique Greece.

The underground alambic model, developed by the antique Greek philosophers, persisted until the XVIIth century to explain the origin of springs. In this model, the sea water was absorbed at the bottom of the sea, then reached the central fire. The produced steam was conducted by channels to underground chambers where condensation created underground lakes, then rivers and springs.

This model was probably inspired by the observation of karstic features in the limestone areas of Greece and Minor Asia :

- the kathavotres of Argostoli (Kefalonia, Greece) where sea water flows in marine shafts were good examples of sea absorption,
- the existence of volcanoes was the proof of a central fire,
- the presence of a steam plume at the entrance of some shafts in winter could reveal the existence of steam channels,
- the drops of water pouring from the stalactites at the ceiling of caves were comparable to the drops caused by the condensation of boiling water,
- the observation of caves with underground rivers was a good indication of the presence of underground lakes,
- karstic springs were easily connectable to underground rivers.

The ignorance of the evaporation and infiltration mechanisms conjugated to these observations make the alambic model a very coherent theory.

147. Manuel Serrano Pinto, Portugal

Gaspar Frutuoso (1522 - 1591) and ideas on ground water in the Azores volcanic islands

This paper focuses on 16th century ideas on the origin of springs and on circulation of groundwater as expressed by Gaspar Frutuoso, a vicar who lived in the S. Miguel island of the Portuguese archipelago of the Azores and who wrote about volcanic eruptions, earthquakes and other geologic aspects of the islands. He studied Natural Philosophy at the University of Salamanca and wrote *Saudades da terra* where such ideas may be found.

Nine islands of volcanic origin in the middle of the North Atlantic compose the Azores. The first islands were discovered around 1430 by Portuguese navigators and by the end of the 15th century all the islands were inhabited.

Frutuoso's description of the streams in terms their location, abundance and uses of water, etc, in each island is very detailed. It is also detailed regarding ponds and lakes in volcanic craters, as well as springs, either thermal or cold, in which the archipelago is very rich. According to him, crater ponds and lakes might be the source of water of some springs.

Cold springs could also be formed from streams that were covered by volcanic material from eruptions (lava, etc.) and so had disappeared from the surface, but the water of which had found underground ways to the sea through openings, caves and channels in the rocks, eventually emerging far from the sea or on the coastal area.

But for him the water of the many springs found on the coasts of the islands had previously been sea water that had permeated into the rocks, had been filtered - and so become less saline - and had found its way again to the sea as spring water.

A most improbable source of good, drinkable water was a submarine spring located at a shoal (S. Miguel) from which water could be collected with a special apparatus described in detail by the author, probably the first ever underwater sampler to be described.

A fourth type of origin of the water of some cold springs was air: entering the ground through its openings, the air would freeze and so would be converted into water (!). New admissions of air into the ground, followed by freezing, would give origin to more liquid that would circulate as underground water until becoming a spring.

For the unusual seasonal regime of springs that become dry in winter and leak in summer the author gives the following explanation: in the hot season the pores of the ground are open wide, allowing for underground circulation and leakage at surface, contrary to what happens in the cold season.

He normally tries to relate the location of springs with high ground around them, so seeming to think that it acts as recharge area. He expresses surprise in seeing a spring at high topographic level (S. Maria) with no mountains around it from where the water might have come. If some of his descriptions of springs make the reader think of artesian water he does not mention the word. Frutuoso refers to rivers of the world partly with underground circulation when he writes about Azorean streams of the kind. Changes in spring water properties (colour, etc.) due to earthquakes are described.

As for thermal springs, he explains the high temperature of the waters by the occurrence at depth of sulphur, alum and "mater of fire" close to the springs.

A comparison is made between Frutuoso's and current ideas of the time.

148. Anne Dubois & Thierry Ruf, France

Ansignan, A Pyrenean valley with many hydraulic historical enigmas.

The bridge aqueduct of Ansignan, situated in the high valley of Agly (Oriental Pyrenees, France) irrigate since more than a millennium the low lands of the village, today recomposed in domestic gardens. The canal going on the aqueduct (which is locally considered as roman) is now managed by a Property owners' syndicate created in the end of the XIXth century and still active nowadays.

The surprising longevity of this building in the time aroused a territorial study with a socio-historic approach of water resource's management and an analysis of the emergent conflicts over the last two centuries.

Two main elements are already identified: On one hand, two poles of strong solidarity (water resource's sharing, presence of canals on several municipal areas...) appear on both sides of an ancient historic border separating the Kingdom of France (corresponding to the high valley) from the Kingdom of Aragon (corresponding to the plain) created by the Corbeil's treaty in 1258.

On the other hand, those two poles, set by the history and subjected to different juridico-institutional regimes, were opposite by recurrent conflicts about resource's sharing: Whether each irrigators' community claims the age-old rights granted on waters, or whether this community notices an inequitable water's distribution in the valley (the presence of one karstic system entails the following situation: whereas the high valley always enjoyed plentiful waters, the plain suffers systematically from severe scarcities in period of low-water mark).

We formulate the followed hypothesis : water's sharing in this valley often provokes conflicts but those ones stimulate the assertion of the rights of each and motivate the protection of the hydraulic patrimony during several centuries until nowadays.

149. Johann W.N. Tempelhoff, South Africa

Rand Water and the Transition to a Multiracial Democratic South Africa 1989-1994.

South Africa's transition to a multiracial democracy in 1994 has been hailed as one of the political wonders of the twentieth century. The major accomplishment was the fact that the change to majority rule did not coincide with violent political turmoil. Much of the success for the transition can be ascribed to the fact that important role players took the necessary steps to secure a smooth transition. Rand Water, South Africa's largest water utility, was one such organisation.

In the paper attention is given to the pro-active manner in which the management approached the transition from the outset. The style of management changed and water utility re-invented itself by undergoing a change of public face.

Amid all the change and restructuring of the political and administrative landscape plans for a new water supply scheme were introduced to increase the 1991-consumption figures of 2328 ML/d up. Rand Water had to cope with an anticipated demand of 4872 ML/d by 2010. Rand Water also started changing its role from bulk water supplier of large local authorities, to that of supplying water to small local authorities and areas historically disadvantaged communities.

Finally attention is given to the participation of Rand Water's management in negotiations with the political role players leading up to the change of government in May 1994. Ultimately the commitment of the water utility to provide a first class service played a small but important role in the transition to a new dispensation in South Africa.

150. Elise Tempelhoff & Johann Tempelhoff, , Sout Africa

The community, industry and the quest for a clean Vaal River 1997-2003.

Since the 1920's the Vaal River on the southern border of the Gauteng Province in South Africa has played an important role in providing the country's economic heartland, with water. The quality of the river's water however deteriorated in the 1930s as a result of an increasing inflow of sewage and industrial effluent.

The result was that the central government, along with Rand Water, the largest water utility in South Africa, over the years made innovative plans to provide the region with water. In what is generally considered to be a country with limited water reserves this was a major accomplishment.

Since 1997, with the introduction of South Africa's new water legislation, a community of small farmers close to the Vaal River and in the vicinity of a large steel factory, took the steel giant to court for polluting the underground water supplies. The process of democratisation, which started with the country's first multi-racial elections in 1994, had empowered ordinary people. It also brought a new type of responsibility for the government – securing co-existence for all sectors of society.

In some respects what is at issue is a sense of empowerment as ordinary people stand up for their rights to clean water and compensation for damage suffered over many years. More important is the task of government to contemplate responsible decision making in the process of conserving South Africa's scarce water supplies.

In the paper an attempt is made at addressing the problem of water pollution from the perspective of a community directly affected. There is also an exposition of how the authorities have attempted to find solutions to a problem that requires decision-making that must take cognisance of the principles of economic development and responsible environmental governance.

151. Olatundun J. Adelegan & Joseph A. Adelegan, Nigeria

The History of Water Services Finance in Sub-Saharan Africa: Pre and Post Colonial Evaluation in Nigeria.

International agreements such as the UN Millennium Declaration, the Johannesburg Earth Summit and the World Summit on Sustainable Development have as one of the specific targets halving the proportion of people without safe drinking water by 2015. However, the present policies, institutions and practices in the delivery of water services in sub-Saharan Africa are failing in their impact on the people.

The Federal and State governments in Nigeria are cutting back funds on water supply, yet the population is increasing, water usage is also increasing and there is increased need for new

capacity expansion and water system replacement. The increase in financial responsibility for water services is worsened by galloping inflation and historically high interest rates. All these have contributed to escalation in the operating and maintenance costs of water supply in Nigeria in postcolonial years.

This paper examines the advantages and disadvantages of various policy options available to Oyo State in Nigeria for assisting with the financing of water service. Pre and Post Colonial patterns of financing water services and their impact on the people is reviewed. Alternative financing options are examined. This includes sources of finance for capital and recurrent expenditures, such as financial provision for investment in new facilities, the extension, replacement and modernisation of existing assets, routine and periodic maintenance of assets, operating costs of systems and the overhead costs of water services.

Alternative financing options for Oyo State and local government include grant and loan programmes, user fees, programme aimed at reducing inflation and interest rates, privatisation of water services, lease / purchase financing and capital market financing through issuance of bonds.

However, there is need to create an enabling environment in which the financial community, be it public, private, internal or international, can bring more finance into the water sector. This will require drastic reforms in the way the water-based industry is organised and delivers services. Institutions in the water services sector need to be more efficient, responsive to clients, financially solvent and commercially astute.

These changes are necessary for the sector to generate and attract increased volume of finance. Part of the finance needed for new investment in the water sector, as well as recurrent operations will have to come through water charges from the users themselves, through water charges. Loans and private equity are ultimately paid from future cash flow from users. The water industry is traditionally a poor prospect for commercial finance. There is therefore need to maximize local funding since cash flow from water is in local currency. Local capital markets in Nigeria can be encouraged to yield more funds for the water sector.

152. Jeremy W. Hubbell, USA

An Umbrella for Un-kte-hi: the Environmental Politics of Development in Minnesota's Wetlands.

In the first attempt of its kind, the technology used in the construction of sanitary landfills and feedlots (hog liners) will be used to protect the passage of the water god, Un-kte-hi, from his home to his outlet at Coldwater Spring. Thus, the battle between environmentalists and half a dozen North American Tribes with the Minnesota Department of Transportation has come to an end. The alternating layers of geotextiles, often described as space-age "Hefty" bags, and aggregate promise to separate the sacred from the profane. The liner sits a few feet above the bedrock fissures and below 9 acres of the roadbed. Water in the spring's recharge area will, theoretically, flow under the liner to go where it will – including, down to the fissures and out of the spring. The run-off from the road should run through a storm water system; the liner will catch any leakage (estimated between 1 and 10 gallons a day, weather depending). The storm water eventually ends up in the river.

This paper will detail how this technologically innovative solution to the final hurdle in the 50-year construction of a highway in Minneapolis details the impossibility of environmentally benign highways. It will also discuss the difficulties that scientific detail and engineering design pose for environmental activism. I will argue that the direct-action campaign of the environmentalists over an adjacent section of the road made it possible for a number of individuals to learn about the spring. In addition, the path to the liner was made possible by the assertion of tribal rights to safeguard sacred space. The attempt to protect the environment in and of itself was fruitless; but the attempt to safeguard a historic use of a certain spring succeeded. When the Tribes and environmentalists came together for the sole purpose of safeguarding the natural flow to the spring, they formed a coalition supported by the state legislature and the governing watershed district.

Unfortunately, the salvation of Coldwater Spring will not change construction practice in America. Though this technology may prove successful, it will not be automatically deployed in hydrogeologically sensitive areas unless activists demand it. However, where water use is recognized, this road design can be deployed to safeguard access to clean water – and it's cheaper than the alternative construction methods or the loss of a sacred spring.

153. Irene J. Klaver, USA

"Whose Water is it Anyway?": Public Good and Private Property on the Edwards Aquifer in Texas.

Critical to the resolution of water conflicts is a common understanding of property rights. Distinctions between common property and private property when applied to water rights and management policies tend to limit discussion of alternative, and potentially more productive ways of approaching water rights. The authors in this paper draw upon recent efforts in Texas to address the management and use of water from a common aquifer that spans seven counties in the south central part of the state. When water law was first codified in 1840, the Republic of Texas recognized the existing surface water rights granted under Spanish law. Yet, the Legislature also adopted English Common Law and with it English riparian water law. This law applied to the vast land grants that were awarded to private landholders.

Yet it is groundwater that accounts for sixty percent of Texas water needs. At the turn of the century the Texas Supreme Court in *Houston & T. C. Ry. v. East* (1904) ruled that the owner of the overlying land can pump and use the water with few restrictions, whatever the impact on adjacent landowners or more distant water users. While the *East* case has been somewhat modified, the "rule of capture" was recently reaffirmed in *Bart Sipriano, Harold Fain, and Doris Fain, Petitioners v. Great Spring Waters of America, Inc. a/k/a Ozarka Natural Spring Water Co.* (1998). The Justices were reluctant to find in favor of the plaintiffs, farmers in Van Zant County who charged that the Ozarka Natural Spring Water Company had lowered the water table and dried up their wells. The Justices in a split decision ruled in favor of Ozarka, but the majority argued that the legislature and not the judiciary should reform Texas Water Law. The authors argue that current conceptualizations found in water rights discourse could actually limit meaningful legislative reform, and offer alternative ways of address rights and use of the common resource.

154. Norman Fuchsloch

Behemoth and some aspects of water administration in Nazi Germany.

Franz Neumann described in his book *Behemoth* the dualistic bureaucratic system in Nazi Germany. That kind of administration also occurred in water management. The former Prussian Board for Water-, Soil-, and Air-Hygiene (Preußische Landesanstalt fuer Wasser-, Boden- und Lufthygiene) was since the unification of the Prussian administration and the administration of the Reich in 1934 responsible not only for the former Prussian state but for the whole Reich. Most of the work of their experts was done in water-supply and sewage-treatment. In July 1941 Fritz Todt as a representative of the Nazi-Party became Plenipotentiary for water and energy (Generalbevollmächtigter fuer Wasser und Energie). Immediately a competition between the two boards arose. At the end, the former Prussian Board became a „Reichs-Anstalt“ (Reichs-Board) and maintained their former position. With the death of Todt the new Nazi-Board became unimportant so far water was concerned. The presentation will focus on the debate in spring 1942, after Todt's death, when representatives of several boards come together to talk about the future responsibilities of their boards. It will be shown that talking about environmental issues means to talk about the balance of power between the participants of the discussion.

155. Julia Obertreis, Germany

State Gigantomania and the Exploitation of Natural Resources – Irrigation in a Central Asian Region 1960s-1980s.

Beginning from the 1950s, the gigantomania in public works, characteristic of the Soviet regime,

led to the blatant misuse of water resources in Central Asia. The consequences of these policies are very apparent today with the desiccation of the Aral Sea, an ecological catastrophe that is accompanied by numerous ecological and social problems.

The best example of Soviet gigantomania in Central Asia is the construction of the Kara-kum Canal through today's Turkmenistan in the 1950s. It was presented as a victory of technology and progress and as one of the "big construction works of Communism". Also many other, smaller canals were built that detracted water from the main rivers in order to irrigate more land, especially cotton fields. The extensive use of the water resources from the main rivers, especially Syr-Daria and Amu-Daria, led to the shrinking of the Aral Sea that was first conceived of in the 1960s.

The construction of new irrigation canals aimed at "making the desert blossom", thus linking the economic need for more raw cotton with a civilising mission, the aim of cultivating new land and territories. Since the colonisation of Central Asia by the Russians in the 1860s and 1870s the colonisers had encouraged and forced the cultivation of cotton which was needed in Central Russia's textile manufactures. The concentration on one "cash crop" such as cotton is one of the typical features of colonial rule in general. And since the 19th century, the extension of the irrigating systems was also seen as a way of becoming "masters of the water" which meant masters of the region.

This paper analyses the relationships and conflicts between local water using communities (forced into kolkhozes and sovkhoses in the 1930s) with their "traditional" background and representatives of central and republic state organs and policies. How could the rural population be integrated into central policies and strategies that were obviously disregarding of the maintenance and proper use of natural resources? The modern idea of protecting environment will be traced. Did it emerge in the region itself from the local population that saw its natural resources abused? How was this idea that emerged in Soviet journals in the late 1960s formulated and conveyed and how did it relate to Soviet policies?

The analyse will focus on one "irrigation region" on both sides of the lower Amu-Daria and its delta. These are all territories irrigated from the Amu-Daria: the oases of Tashauz, Urgench, Buchara (partly), Chiva and the territory of Karakalpakistan. Today this region belongs to Uzbekistan and Turkmenistan, and in the Soviet period it was the Uzbekistan and Turkmenistan Socialist Soviet Republics. Main sources used are Soviet monographies and journals such as "Agriculture of Uzbekistan" (Sel'skoe chozjajstvo Uzbekistana) and "Agriculture of Turkmenistan" (Sel'skoe chozjajstvo Turkmenistana).

The study the paper is based on is a contribution to the water history of Central Asia and to a history of colonisation and colonial rule in this region. Through writing the history of irrigation it will contribute to the history of Russian and Soviet colonial regimes and their impact on the development of periphery regions.

156. David Pietz, USA

Floods, Drought, and Pollution: The Huai River during the People's Republic of China, 1949-1999.

This paper will explore the changing context of Huai River management during the People's Republic of China (1949-). More specifically, the paper will explore such themes as: centralization vs. decentralization (of water management), mass mobilization, labor-intensive vs. capital intensive investment priorities, and economic development vs. environmental protection, and self-reliance vs. international technical and financial cooperation. In general the paper represents a broad overview of the changing context of China's water management (or resource management) spanning the Mao and post-Mao period. The critical question is how has China's water management, as reflected by Huai River conservancy programs, evolved over the past fifty years, and what have been the outcomes of these different approaches, and how the the different development paradigms that these approaches have been embedded in have fundamentally altered the landscape (both human and environmental) of the Huai River valley.

157. T.N. Narasimhan, USA

Science and Culture in California's Water History.

The state of California provides a remarkable human experience in regard to the development of water and natural resources for social benefit and for profit. Considering its area (about 400,000 sq. kms.) and its diversity of landscape and climate, California's experience should be of great value to many nations around the world as they try to set in place rational resource management policies in a technological world. A century and a half ago, a practically virgin land with associated waterscape fell into the laps of an energetic immigrant population, eager to conquer nature for prosperity with the emerging tools of the industrial revolution. The nascent society in the new-found land gave itself the most liberal laws and policies that democracy could offer to achieve the desired prosperity. The freedom motivated the development of spectacular technologies to harness and move water, to drain lands, and to grow crops. California grew up to become the sixth or seventh largest economy among the nations of the world. If so, has California demonstrated to the world that freedom and motivation can help all nations prosper in its own image?

Despite the economic success, the science and technology of the past more than a century did not quite foresee the potential impacts of its own successes in harnessing, moving, draining and putting water to beneficial use, on the overall landscape, the soil, the ecosystems and the biological environment. The same science that set out so eagerly to conquer nature and make deserts bloom is beginning to note that California's natural resources infrastructure is finite (although large), and is vulnerable to the vagaries of climate. As result, developing the state's water resources to support present rates of economic growth is unsustainable. Consequently, the state as a whole is in transition, adapting itself mentally and physically to the challenge of sustainable living in a finite earth system. The transition is a difficult and challenging one, taunting scientists, policy makers, and the lay persons alike. How Californian's adapt themselves to their natural resource circumstances in the future should prove to be an equally impressive human experience.

This paper explores the connections between scientific developments and cultural traditions that have shaped the history of water development since 1850, when California became the 31st state of the Union. The paper will be in three parts. The first part will describe the natural setting of California and the major scientific and technological developments that helped the state to harness its land and water for human benefit. The second part will outline the cultural traditions that guided human perceptions and the laws and policies that evolved to help harness the natural resources. The third part will examine the interactions between technology and policy. This would illustrate the continuous evolution of a vibrant society, as it adapts itself to the inevitable recognition that, in a finite world subject to delicate balances among nature cycles of water, nutrition, and life, human aspirations have to be subordinate to relentless laws of nature.

158. Remy Courcier, Aida Jdri, Francois Molle

Water in the Jordan Rift Valley: Who Gives and Who Receives?

The Jordan Rift Valley is a crucial natural and geo-political artery of the Middle-East. From ancient times to the construction of large-scale irrigation and urban water facilities in the second half of the 20th century, and to the current struggle for water in Jordan, the appropriation of its water has been constantly remodelled and re-ordered. The paper provides a historical retrospective of such transformations, with a focus on the current viewpoints and meanings of its "development" as well as on the allocation of water itself.

159. Pradeep Shrivastava, India

Multiple Stakeholders, Rights, Benefits and Responsibilities in Water Use.

A typical urban lake in a developing country faces many problems with respect to allocation of rights of water use and responsibilities of its ecological management, among its various stakeholders. Perhaps the objective of the origin of these water bodies, with the passage of time with development taking place, shifts or some times expands. As a result composition of its

stakeholders also changes, which in turn questioned the sharing of its benefits and responsibility of management for its sustenance and regulating the uses, allocation of water rights and ownership.

As with many resources, when water is abundant there is relatively little attention given to rights to use it. But with increasing scarcity and competition for this vital resource, there has been a growing attention to water rights in recent years. Unfortunately attention has been paid to only formalized statutory rights. Water rights have to be seen not only from the formal statutory view point but other basis of claiming water should also be considered. Formal laws are important but they fail to coincide with peoples own perception of water rights. Recommendation made exclusively on one type of regulating law may not adequately address the problem of resource allotment and responsibility of their management. The policies and legal changes, change the rights radically from locally accepted notions. The water availability and demand fluctuate from year to year. Stronger water rights still work even during scarcity periods, weaker rights may be declined.

In the present case study users and managers have been found to be two different classes inhabiting catchments and area out side catchments of the water body. Individual users often occupying area out side the catchments receives multiple benefits without responsibility of management for its sustenance. Whereas the other class called managers, without any right to water or deriving benefits from it, has to, at individual level bear the burden of its ecological sustenance.

Certain users ceased to have their rights of access to water in due course of development/urbanization of the area even their physical closeness to the resource has not been of any help in continuation their rights to the water. It has also required them to change their livelihood pattern or some times totally abandon the traditional profession, farming in most cases. Statutory rights (drinking & irrigation) have adversely affected the other users (fisheries, religious, aquaculture practice, recreation etc) in the present case during scarcity period.

160. H. Walter Cazenave, Argentina

The "Artesiano"Ditch: A Technological Resource which Changed Society and Economy in the Pampas.

The big development Argentina had during 1880 and 1920 was based on its cattle first, and on its agriculture later on. Givent he excelent environmental conditions in the Pampas, cattle existed at least since three centuries ago, though quite bounded by lack of suitable improvement technologies. The main were obstacles were two: 1) handling difficulties in cattle inclosure; 2) watering safeless permanence.

The first of these problems was solved by the wire-netting introduction, near 1850, but water problem remained, especially in the west, on indians lands. Cattle inclosure proved to be useless in a region like the pampas, alternatively subdued to droughts and floods.

Beverage and animal permanence were secured as long as there were surface waters: lagoons, rivers and streams; but as they diminished its flow or got dry, it was necessary to get rid of cattle not to lose money. Besides, the dag ditches which allowed subterranean layers were unsafe, non practical and difficult to dig in regions where rain was less than deep water.

With the first "artesiano" ditch hydric development changed definitively cattle management and development, and its asociated industries or activities. An outstanding suces --not very well remembered by the way- took place in 1862, when the french Adolfo sordeaux extracted water in Buenos Aires province using the artesian ditch. This succes, added to the wind-mill appearance, coming from U.S.A. in 1880, allowed a fast and deep cattle frontier displacement: more than 800 km westwards in twenty years, making of a rudimentary pastoral society one of the world richest meat producer region.

161. Svetlana Verbych, Ukraine

Hybrid Technology for Wastewater Treatment

The one of the main source of water contamination with heavy metal ions is the wastewater of the galvanic production. The valuable heavy metals have been wasting irretrievably and at the same time they poison environment and form sludge, which is hard to treat.

The new conception of the water treatment management to prevent sediments contamination and to protect environment is declared in the frame of the present work. The proposed approaches are based on the suppression of the heavy metals migration into waster water by means of ion exchange extraction of the particular heavy metal ions from the rinse water after electroplating process.

The static and kinetic nickel, copper, zinc, cadmium and chromic adsorption by the universal cation exchange resins KU-2 type of the gel structure with functional sulphate groups and carboxyl containing microporous polyampholyte ANKB type were investigated. It was found that the adsorption of heavy metal ions for both types of ion exchangers was limited by the ion diffusion in gel phase. The selective extraction of heavy metal ions by ion exchanger ANKB is quite effective since the complex formation functional groups are present in the resin grain. They form additional co-ordination binds in the polyampholyte ANKB-35, which led to formation of strong complexes of transition metals. However the high value of the ion exchange capacity and the lower commercial cost of the ionate KU-2 comparing with the amphoteric ion exchange resin ANKB seems to be more attractive for wastewater treatment.

On the basis of this research the ecological and economically advantageous technology for rinse water purification from nickel ions has been developed. The technological scheme of the extraction of nickel ions from rinse water of the galvanic process and the pilot installations were examined. Ion-exchange column is placed along the plating line, through which solution is continuously pumped from drag-out bath. After resin saturation of the first column with metal ions solution flow of the drag-out bath is passed into the second column. The used up column is connected to regeneration path by other pump. The quantity of the sorbent for the column is selected in such a way that heavy metal ions concentration in the drag-out bath for the period of working shift did not exceed a certain value. For example, for nickel ions the given concentration is about 70 mg/l. During multiple solution circulation with rate more than 10v/h, independent of sorption-regeneration cycle, nickel ions concentration, in the drag-out bath does not exceed the indicated quantity, while in flow-type rinse bath will always be lower than the maximum permissible concentration. After resin saturation the column has to be regenerated with the acid solution, and simultaneously with the regeneration process the electrodeposition of nickel from regenerative solution occurs on the electrode. This adsorption technology allows to prevent nickel ions occurrence in the wastewater, reuse treated water into technological process and to obtain pure extracted metal that can be used as an anode in the electroplating process again.

162. Nefissa Naguib & Mariken Vaa, Norway

Models and Realities in Domestic Water Supply.

The United Nations International Drinking Water Supply and Sanitation Decade (1981 - 1990) ended in a global consultation where experts from 115 countries agreed on the following guiding principles for water development:

- Protection of the environment and safeguarding of health through the integrated management of water resources and liquid and solid wastes.
- Institutional reforms promoting an integrated approach and including changes in procedures, attitudes and behaviour, and the full participation of women at all levels in sector institutions.
- Community management of services, backed by measures to strengthen local institutions in implementing and sustaining water and sanitation programmes.
- Sound financial practices, achieved through better management of existing assets, and widespread use of appropriate technologies.

These principles summed up insights gained from the high failure rate of earlier water development interventions, where water supply was primarily seen as a simple task of engineering. They have in various forms been endorsed by both donor and recipient countries' governments. To what extent they are actually guiding the practice of developing countries' sector institutions and donor agencies is not well known, but probably variable.

This paper discusses some of the main political and institutional reasons why developers rarely choose appropriate technologies and often fail to ensure the involvement of women and community management of services. This provides the background for an in-depth study of a village in the Palestinian highlands. Here the provision of piped water to households, although welcomed, has had unexpected consequences for the lives of women. The established picture of Third World women's subordinate position within their households and communities is challenged by the images these women have of their chores of managing 'their' household water. In this patriarchal society, domestic water supply involved the entirety of women performances and experiences. The complexities of this specific case imply that water development is not as straightforward as is often assumed. Development interventions in domestic water supply aimed at empowering women need to integrate existing institutions as well as local knowledge.

163. Dragica Stojiljkovic, Yugoslavia

Contribution to History of Legislation Regarding Groundwater Protection.

In Serbia, 19th century is known as period when health food, noise, high-quality drinking water, soil and air protection, but also environmental protection, were very important. After Turks reign, new country made legislation for the first time in 1850. Of 40 paragraphs in the legislation, five are related to water protection. As these paragraphs were made 150 years ago, they can be defined as "hystorical" ones. It is interesting to note that all of them analyze individual infractions, which means that production activities in Serbia were not of so significant volume of production, hence, water objects and environment were not disturbed by them.

At the territory of today's Vojvodina, within Austria-Hungarian legislation, the first law in domain of water protection, regulating flood protection, was made in 1807. Under available water, all spring, atmospheric and ground waters present at the private property were considered. Owner was permitted to use and to perform appropriate work. Under controlled water, it was possible to use water as public property - for sailing, rafting, washing, watering, bathing, water power consumption and water supply. For other purposes, licenses and rental agreement for some period were issued. Use of water for irrigation was not regulated as other purposes, because, at that time, flood protection, surface water management, soil draining and individual water supply were of primary importance.

During governmental authority of Obrenovic family, Law on Water was made in 1878, where surface water management in state and private property was regulated in similar way.

Analysis of rules regarding environmental protection in today's Yugoslavia shows that this topic is regulated by numerous rules of different level and character. Some of them are directed to problems of environmental protection and some media of the environment, while some have certain influence on strictly defined questions of the protection of the environment. Exploration, exploitation, management and protection of water is regulated by the following legislation acts: Law on basic geological activity of interest for the country, Law on geological exploration, Law on Mining, Law on aquifer consumption and protection for water supply, Law on environmental protection, Law on spas, Law on waters, etc.

164. Nicholas S. Hopkins, USA/Egypt

Water Conservation in Egypt: A Socio-historical Analysis.

Thoughtful Egyptians are beginning to realize that water conservation is essential for the future water supply of Egypt. The per capita amount of renewable fresh water in Egypt is now just under 1000 cubic meters, generally taken as marking the scarcity level, and will decline as population rises. Virtually all of Egypt's water comes from the Nile, and is part of accords and relations with

other Nile basin countries (Waterbury, *The Nile Basin*, 2002). Roughly 85% of Egypt's water is used in agriculture, with the rest divided between industry and domestic use. In this context, what is the role and future of water conservation?

Any substantial savings must come from agriculture, the biggest user. To some extent this depends on high-level decisions (for instance, on the engineering aspects of the irrigation system, or the cultivation of a water-demanding crop like sugar cane). But also much of it depends on the actions of the myriad of small farmers in the Nile valley. This paper thus examines the practices and behavior of farmers with regard to water use and misuse. A key part of this debate is the issue of getting farmers to pay for irrigation water (they currently do not): why and how. Use of water for irrigation also implies drainage, and thus we must examine the different ways in which farmers categorize and use water. As the rural population grows, disposal of solid and liquid waste becomes more of a problem; the traditional solution of dumping waste in a canal with running water no longer suffices.

Urban dwellers also have a role to play in water conservation. There is a considerable literature on how water is acquired and used in poor urban neighborhoods, and disposal of waste water is also a problem (Hopkins, et al, *People and Pollution*, 2001). Water management in the household is a factor. Factories also use a good deal of water.

Most plans for conserving water in Egypt require substantial social participation. Yet this is not easy in Egypt, where most forms of social mobilization contravene the emergency laws and disturb the authorities. People may wonder why they should economize on water when their neighbors do not. This paper examines water conservation strategies at the household level in urban and rural areas, and suggests improvements. At the same time it examines the major choices in agriculture, and notably efforts to persuade farmers to use water more efficiently - through improved technology, pricing, and the like. The paper concludes with an effort to use present trends to peer into the future.

Abstract prepared for the International Water History Association conference, Cairo, December 2003. Could be included in the symposium on "The management of water resources in the Nile Basin."

165. Declan Conway, UK

From Headwater Tributaries to International River Basin: Environmental Change in the Nile Basin.

Rivers draining large river basins integrate the interplay of change proximate and underlying drivers of environmental and societal processes across a range of scales. Whilst the results of some activities may not directly affect the runoff process, many aspects of environmental change may alter river characteristics. The temporal and spatial scales at which many processes of change occur will be important for understanding the downstream consequences of upstream change. Incremental changes across time and space may cancel out certain effects or begin to cumulatively affect runoff and river flow characteristics at detectable levels against baseline conditions. The Nile basin is used here as a geographical unit to explore processes of environmental change acting across a range of spatial and temporal scales.

The paper considers three environmental change phenomena manifest in the headwaters of the Nile basin: land cover and land use change in the upper Blue Nile basin; soil erosion and downstream reservoir sedimentation in Ethiopia and Sudan; and historical climate variability and future climate change in the headwaters of the White and Blue Niles. The focus will be primarily, but not wholly, on tributaries draining the Ethiopian Highlands which contribute around 70% of overall Nile discharge. The aim is to explore change that is manifest locally but with regional and even international consequences through its effects on Nile river characteristics.

Prior to the end of the Dergue regime in 1991 there was very little published empirical research on environment in Ethiopia whilst the last decade has seen a significant increase in research and publications on this theme. Post 1991 much of the research and many publications have taken a questioning and even revisionist approach to earlier understanding and perceptions of environmental change. The results of empirical process studies of soil erosion, land degradation

and land cover change have significantly broadened the knowledge base and understanding of contemporary rates of change and the complex interplay of human activities. As research findings accumulate the picture that emerges is one of complexity that undermines many of the assumptions and generalisations that were widely circulated in the 1980s and early 1990s. Progress in these areas will be discussed in relation to scale and downstream effects.

New and updated analysis of rainfall records for the two key source areas of Nile flow, the Ethiopian highlands (around 70%) and Lake Victoria region (around 15%) highlight the magnitude and importance of climate variability for local, regional and international water resources management. Decadal variability in Ethiopian highlands rainfall has driven marked fluctuations in downstream Nile flows, with a particularly dry period from 1978-1987. At regional and local scales very dry years and sequences of dry years have been associated with significant acute food security events which are superimposed on longer-term chronic food security problems in the highlands. In the Lake Victoria (White Nile) system extreme wet years and secular increases in October-November rainfall, combined with amplification and storage effects of hydrological systems, especially Lake Victoria, have led to prolonged large shifts in lake levels and river flows with important consequences for water resources management. The potential impacts and high level of uncertainty associated with projections of future climate change underscores the need to manage water prudently with careful consideration of uncertainty in both future supply and demand for Nile waters.

Finally the paper will use the complexity of these examples to explore the linkages between local-level environmental change in the Nile headwaters and their implications for understanding environmental change at the larger scale of the Nile basin.

166. Pieter A. van Brakel & Sam Berner, South Africa

Challenges and advantages of establishing an information portal for an information system on water research.

Portals, a further development from what has become known as a Web-based directory of information hub, and particularly so-called information portals, present unique strategic challenges in any research environment. An information or content portal is able to organize large collections of content (information resources) and based on the subjects they contain, can more effectively connect the right people with the right information. Two types of information resources are referred to: Internal, institutional and/or unpublished research-based content, as well as external content, such as large commercially available bibliographic and full text databases, news feeds, research results databases, dissertation databases, and so forth. An enterprise or institutional information portal has the capability to link and integrate internal with external content.

To put information portals into perspective, three generations of Web environments can be distinguished in an effort to indicate more clearly the features of a portal:

§ An Internet Website, the most basic manifestation of Web, allows end-users to search for digital documents on water research and following relevant links to other resources; '... it is intended for public consumption without restriction'.

§ An intranet Web, developed for the staff of an enterprise, concentrates on providing relevant information solutions to an internal community; access is limited to an authentication process.

§ On the contrary, a portal is a sophisticated gateway to the Web that allows the plethora of information on Internet and intranet Web sites to be organised and customised and personalised through a single entry point.

The following elements provide a more detailed analysis of the information portal - a mechanism that should be built into any environment where research on water, and the history of water, is taking place:

§ Access point: A single gateway or logon to identify approved users. This refers to a desktop-orientated function: it prevents the user from having to sign onto each of the different systems that provide portal content.

§ Internet tools: These are site search and navigation tools to provide users with easy access to information. Examples given are calendars and planners to allow users to input and share events, as well as Web site and content builders, offering them the ability to create and have customized content being made availability according to individual profiles.

§ Collaboration tools: These include e-mail, threaded discussions, chat and bulletin board software that offer a whole range of ways to communicate and share information.

§ User customization: A typical portal prompts the first time user via a series of fill-in windows to provide information about him/her. This is then stored in the portal's database. When that user authenticates to the portal, this information will determines what he/she will see on the homepage immediately after login.

§ Channel information: User-defined channels from both internal and external (information sources). Examples are, inter alia, research information, statistical or assessment information, and links to other useful sites.

§ Pushed information: This refers to user-defined and selected content which is sent to legitimate users, such as news, events or specialised memos.

§ User personalisation: A good portal let you take customisation one step further, that is, to enable an end-user to subscribe and unsubscribe to channels and alerts, set application parameters, create and edit profiles, add or remove links.

This paper will investigate portals from an informational departure point, and concentrate on the last four elements of the above list: Customisation, channelled information, pushed information, and user personalisation. The topic of water research, and specifically the strategic role that an information portal can play in this type of research, will be discussed in detail. A taxonomy of water information resources will be presented, indicating how these resources could be effectively made available to researchers in the various water research disciplines.

167. Shavkat A. Rakhmatullaev, Dilshod R. Bazarov & Jusipbek S. Kasbekov, Uzbekistan

Historical Irrigation Development in Uzbekistan from Ancient to Present: Past Lessons and Future Perspectives for Sustainable Development.

The paper discusses the four main historic periods of irrigation in Uzbekistan. They are known as ancient times, feudalism, Soviet era, and post-independence periods. The authors argue that this division enables readers to better visualize and understand the irrigation developments. The infrastructure, management hierarchy, the water allocation issues are discussed. Uzbekistan is one of the most ancient areas of irrigated agriculture. Here, as well as in all countries of the East and arid zones, "the climatic conditions have forced development and use of primitive artificial irrigation infrastructures to grow food and sustain livelihoods. Ancient civilizations have risen and fallen due to irrational water management and water wars on water. The research and archeological studies indicate the existence of Ancient farming culture of Margiana, Sogd, Fergana, Khoresm, Northern Bactria and ancient irrigation lands in lower reaches of Amudarya, Syrdarya and Zarafshan rivers and have shown that irrigated agriculture in Central Asia originated mainly in two geographic hydrologic favorable zones: in valleys of foothills and flood-lands or deltas of great flat rivers of Syrdarya and Amudarya.

For example, the interesting water allocation mechanism was practices in the region. Most important government official was the chief Mirab who had considerable Distribution of water at a village level was overseen by a water controller, the Mirab, who in turn, was supervised by a village elder who was elected by the people. It was the responsibility of the Mirab to ensure that every one linked into the irrigation system received their fair share of water.

Improper management and decisions have caused severe environmental problems such as desiccation of Aral Sea. Like the Tsarist rulers before, the Soviets believed that Central Asia could become a major cotton growing region if the irrigation network was expanded. But while Tsarists

plans failed because they were dependent on financing from the private sector, the Soviets covered the construction costs of large scale irrigation schemes from central funds.

In order to sustainable development of the region and rational natural resources management without harm to environment and economies, local policy makers and planners and international institutions that are actively participate in funding irrigation projects need to know the history of irrigation development of the region and learn past failures for future successes stories.

168. Erik Swyngedouw, UK

Flows of Power : The Political Ecology of Water and Urbanisation. The Case of Guayaquil, Ecuador.

This paper contributes to the formulation of a political-ecological perspective on the process of urbanisation. The objective is to excavate the political-ecological power relations through whom water becomes urbanised and, subsequently, how the control over and access to water has become socially highly stratified. In the case of Guayaquil, Ecuador, for example, 35% of the more than 2,000,000 inhabitants have no access to piped potable water. This paper seeks to document and analyse the power of water in the context of Guayaquil's urbanization process and to suggest strategies for an emancipatory and non-exclusive production, conduction, and distribution of urban water.

The paper analyses the political-ecological dynamics through which the contemporary urban waterscape and hydrosocial cycle in Guayaquil became constituted. We shall undertake the archaeology of the urban water networks, and reconstruct how Guayaquil's 20th century history became etched into the technical, social, and ecological structures of the water system. This history and current geography of the city will be written from the perspective of the necessity to control and harness water flow into and around the city. The socio-economic and political-geographic power relationships determining access to or exclusion from water will be analysed in the context of Guayaquil's urbanization process. In addition, I shall explore how these practices vindicate social and economic power relationships at the local, national and international scales. Attention will be paid to the 'Water Mandarins', which organize and control the production, conduction and distribution of urban water in Guayaquil, will be charted with a focus on their internal and external relations. This will include an analysis of the relationship between external funding agencies (the World Bank and others), national government, and the local and recently privatised water company. In addition, infrastructure and investment planning, price mechanisms, and control structures will be explored in the light of the disempowering mechanisms of the existing water system.

In the final section, the struggles for water power will be excavated.. These struggles exemplify the dynamics of the Guayaquileño urban political-economy and highlight the mechanisms of domination-subordination and participation-exclusion in the context of peripheral urbanization processes. Attention will also be paid to 'people's power', to the weapons deployed by the weak, and the ingenuous mechanisms mobilised by individuals and social groups alike to secure access to at least some of the available water. The section will conclude with a discussion of the struggles over access to water in the practices of everyday urban life. We shall conclude by considering strategic issues related to the possibilities for an emancipatory and empowering development.

169. Ngahuia Dixon, New Zealand

Cultural Significance of Water to Indigenous People in New Zealand, and the Effects of Non-Indigenous Water Usage and Management.

The Maori people of New Zealand are recognised as the indigenous people of the country. Our traditions and beliefs acknowledge a cultural link to many of the water bodies within New Zealand. These different water bodies, i.e. lakes, rivers, and coastal areas are under the guardianship of local tribal groups who live within the immediate locality.

Ways in which the rivers are used, protected and respected are a part of everyday life and are included in rituals at functions where and when kin groups gather. The water bodies are also an icon of tribal prestige and heritage, and are revered as a living cultural entity.

On the other hand formal authorities and other organizations local and national use the waterways for purposes which are deemed offensive and challenging to indigenous people. The use, protection and proper management of these water bodies has been a bone of contention for many tribal groups, where legislation has seen indigenous views ignored.

As indigenous people of New Zealand we are all too aware that water is a primary resource which is required for the community good. In our view this is a legitimate argument for water usage, but its use for biased gains, assisted by various pieces of legislation locally and nationally is anathema to the cultural thinking of Maori people.

This paper aims to present indigenous views of water, its use, protection and management through a window of cultural processes. It will contrast our views by presenting other non-indigenous water usage, management processes and other activities within New Zealand creating different views of the significance of water.

170. A. Rajagopal, India

Dynamics of Water Institutions and Livelihoods of Poor in a South Indian Canal Irrigation System over a period.

The paper is about the water insecurity situation in an irrigation system, factors contributing to the scarcity condition, the role of institutions in reducing water insecurity and improving the livelihoods of poor. The paper also analyses the dynamics of these institutions over a period and their impact on farmers' livelihood. These observations are based on a study of a canal irrigation system in South India in 1980s and a resurvey of it after a period of 15 years.

The study rests on the premise that irrigation institutions and their role in management are significantly conditioned by the agricultural and socio-economic environment especially caste and class of the region. Maintenance of irrigation structures and regulation of water supply to tanks under large-scale irrigation system is fully the responsibility of the State. However the State is not able to undertake these functions efficiently due to its own constraints. Hence local level irrigation organisations undertake maintenance like cleaning and de silting of channels, which bring water to their tanks. Though the State is not able to regulate water to the tanks properly, local institutions themselves undertake such tasks. Collective action both in the appropriation of water from the main canal and allocation of water at the local / tank level is quite significant. These organizations called panchayat have well defined structures, rules and functionaries. The members of the panchayat are generally farmers with relatively larger land holdings and community influence in the village. They are assisted by professional watermen and watchmen, appointed during every irrigation season and paid through the farmers' contribution. Thus collective action as regards functions of water management is quite significant and brought substantial benefits to farmers including small farmers in terms of access to water and productivity gains from irrigation. Had there not been such institutional arrangements there would have been substantial losses to farmers (especially small farmers) because of overall reduction in the quantum of water in the system due to the inter-state river water dispute and the increased problems due to encroachment and alkalinity of soils.

Though there has been a significant change in the land control, the villagers continue to show interest in collective action as majority of their livelihood depends upon agriculture for which irrigation is the basis. Not only irrigation but also the very life of villagers depends upon cooperation among themselves for the fear of subordination by the dominant castes. The continued presence of irrigation institutions and their role in water management and other village affairs point to the fact that pessimism expressed on collective action by theorists of 'tragedy of commons' like Hardin, and Gordon is exaggerated.

The resurvey shows that irrigation systems do not exist as blue prints but continue to undergo changes in which institutions are important. Though there are many changes in irrigation and

agriculture, caste as an institution continues to play an important role in irrigation and other village affairs.

171. Meriam Addou & Ahmed Benhammou, Morocco

Water and Wastewater in Morocco.

Morocco is characterised by very marked regional disparities as well concerning relief, climate, precipitation volume that concerning water availability. The north hydrological Watersheds are very favoured as regards water resources compared with chronic deficits raised in south watersheds.

On the 150 billions m³ representing the yearly precipitation, only 30 billions m³ flows out in surface or infiltrates to either form or feed groundwater; the remainder being lost by evapotranspiration. If one deducts losses by evaporation, uncontrollable out-flows toward sea and desert, the hydraulic potential available at the current technical and economic conditions rises to 21 billions of m³ on average yearly, which 16 billions of m³ from the superficial resources and the remainder from the underground resources. The main users of water are irrigation and water supply. At the 2020 horizon, several watersheds will present a large water resources deficit. Therefore, it is programmed to achieve several works (dams and drillings) in almost all watersheds that guarantee an available resource on the order of 15,5 billions of m³. Waters of the existing dam whole are generally good quality. Superficial and underground waters quality varies from one watershed to another, it is from very bad to good. It is due to the direct discharges of cities and industries as well as to the infiltration of irrigation waters charged in nitrogen in groundwater.

Wastewater treatment remains the component that knows the more of backwardness. About fifty Wastewater treatment plants has been constructed since 1958 in Morocco. More than 80 percent of those plants are now out of service. This problematic shows the management failure of the local communities as regards sanitation.

One assesses costs of natural resources deterioration to 20 billions, that is 8,2% of the national GDP. This deterioration has an ominous impact on the socio-economic development of the country.

172. Md. Rashedul Islam, Bangladesh

History of Water Laws to Resolve Conflicts on Transboundary Rivers and Future Directive.

Transboundary rivers flow over several territories. Any regulation on such rivers has pronounced impact on the users of the downstream countries. As many rivers of the world are transboundary in nature, conflicts among nations are rising at an alarming rate. Over 3600 treaties can be identified on international water bodies in history. Recent trend has been observed to set laws on transboundary river regulation which supposed to be accepted by all countries. Prof Smith (1931) showed legal aspects on his book "The Economic Use of International Rivers". He emphasized the doctrine of riparian rights, which entitled the lower riparian states to a share of the natural flow of a river. Thereafter, Dubrovnik rules for international rivers came out in 1956 by the International Law Association (ILA). In 1966, the same authority proposed Helsinki Rules. The objective of the Helsinki rule was to introduce a drainage basin concept on water laws. But all countries of the world did not accept these rules. Later, International Law Commission (ILC) of the United Nations decided to begin with the formulation of general principles. In 1991, the ILC produced a draft report on the law of the non-navigational uses of international watercourses. In 1997, the UN General Assembly approved the resolution on non-navigational uses of international watercourses.

In spite of this convention water conflicts in many transboundary rivers (e.g. Mekong river, Ganges river etc) is noteworthy. A major problem of the proposed convention is that, in many cases it has no specific direction rather generalization is significant. In this study, it has been directed to develop a more specific set of rules gradually, which can be helpful in resolving water conflicts in future.

173. Hani Nabhan Sewilam, Germany

Modeling in Water Resources: From Numerical Methods to Computing with Words

Mathematical models have long been known as powerful tools to solve water resources problems. Most of available models are crisp, deterministic and precise in character. However, many of water related problems are ill-defined (e.g., ecohydrological processes, human behavior) when the only available information consists of expert knowledge, which is formulated by words from natural language. Also developing of decision systems to support integrated water resources management faces great difficulties not only because of the interrelationships between technical, economical, social and environmental aspects but also due to the difficulties of participating ecologists, economists, sociologists and hydrologists in the modeling process. For example, while ecologists use natural languages and qualitative reasoning for the description of ecological relationships, hydrologists communicate in the form of systems of differential equations or analytical models. Unfortunately, numerical models are not well suited for dealing with uncertain situations or qualitatively described processes.

Computing with words (CW) is a modeling technique in which words are used in place of numbers for computing and reasoning. Fuzzy logic is the core of CW, it enables to transform these expert words into numerical models with less efforts and low cost. Recently Artificial Neural Networks have been introduced to fuzzy logic to form so called NeuroFuzzy System which exploits the strengths of both techniques best while reducing their weaknesses. A numerous number of applications worldwide are already existed, however water specialists are still relatively out of competition.

This paper will scope on the limitations of traditional numerical models and the need for CW as a new modeling trend in water resources to deal with uncertainty, partial truth and qualitatively described knowledge. The basic principals of different CW-techniques will be illustrated with examples for their applications. The possibility to link together experts in different disciplines to solve water problems using a CW-based common modeling language will be discussed.

Keywords: Modeling Techniques, Water Management, Fuzzy Logic, Artificial Neural Networks, NeuroFuzzy Systems

174. Robert G. Varady, USA

Global Water Initiatives since the International Hydrological Decade (1965-74): Their Evolution and Significance.

The proposed paper is a brief history of institutions known as "global water initiatives." Each of these initiatives has sought to improve society=s management of the planet=s water resources. The phenomenon reflects a post-World War II trend-in this instance, beginning with the International Hydrological Decade (1965-74)-toward collective approaches to resolving multinational issues in general and common-pool resources in particular. The central question to be addressed is whether the 'world of water' would have been much different if these initiatives did not exist? The paper is part of a project that aims to formulate a critical history, synthesis, and assessment of the global-water-initiative phenomenon since the early 1960s.

Global water initiatives have proliferated because of the general belief within the water-development community that water transcends national boundaries and must be managed cooperatively, equitably, and with reference to the best science. The paper will offer a preliminary evaluation of the effectiveness of these initiatives, which arguably have become the dominant model for international water-resources management. Based on lessons from a half-century's experiences, the results should interest scientists, social scientists, diplomats, and managers, and especially decisionmakers at all levels, who "need to ask questions about history and to reflect on the past before they can address contemporary challenges" (Martin Reuss, in "Historical perspectives on global water challenges," Water Policy 2000).

Over the past two decades, numerous environmental historians have studied aspects of water in different societies. The proposed paper looks beyond individual regions or topics and instead analyzes a metaprocess: the rise of institutions with genuine expectations of influencing water management on a global scale. The paper will be based on field research and preliminary analysis

to be accomplished in the course of a sabbatical by the author in Paris, France, beginning in September 2003.

175. M. Khorshed Alam, Bangladesh

Citizens' Movement to Save the Buriganga River in Bangladesh

Dhaka City, now the capital of Bangladesh, was established and developed on the bank of the Buriganga River in the early 1600s as a provincial capital of the Mughal ruler mainly because of easy riverine communication. Over the years, along with residential development, many industries and factories have been developed on the bank of the river using it as a "natural sink" for both solid waste and industrial effluents. The river plays a very significant role in providing sanitation, water supply, drainage, riverine transportation and flood control for Dhaka City. However, although the Buriganga River is considered to be the lifeline of the capital, within the city the river has become biologically and hydrologically dead in recent years because of indiscriminate dumping of domestic and industrial wastes, encroachment by illegal structures, and failure on the part of the authorities to enforce rules and regulations pertaining to ecological health of the river. Government response has been very little, except to form committees to examine the extent of damage done to the river and finding its causes, and lofty promises to save the river. Against the backdrop of failure on the part of the government to respond to a call for immediate action, a group of people from within civil society emerged and formed a pressure group. So far this group has had some successes in highlighting the importance of the river for the existence of Dhaka City to policy-makers and the public. As a result, unabated encroachments have been stopped, some illegal structures have been removed from the riverfront, and a proposal is underway to establish a wastewater treatment facility.

The paper describes the uses of the river and historical development of the riverfront as a major source of recreation and sites for industrial growth as well as the way the river's health has deteriorated. It gives the history of the river turning from the lifeline of the capital city to a biologically and hydrologically dying river. The paper focuses on the on-going struggle of the citizen group trying to save the river through developing awareness among the public about the carrying capacity of the river and to create pressure on the regulatory authority to adopt adequate measures to undertake the cleanup programme for the Buriganga River.

176. Maria Kaika, UK

The Water Framework Directive: a new directive for a changing social, political and economic European framework.

The paper examines the intricate process of developing the European Union's Water Framework Directive. It sees the Directive as a response to recent economic, political and social changes related to water management, including the shift from government to governance, the liberalisation of water markets and the emergence of a new set of institutions, actors, etc. and their respective relations (i.e., social capital). The paper focuses on the key points of disagreement between the Council of Ministers and the European Parliament that threatened to prevent the Directive from being materialised and interprets this controversy as the culmination of conflicting interests between different actors at the local, national and European levels. Finally, it asserts the increasingly important role of the nation state in the decision making and implementation of the Directive and sets this against recent arguments about the death of the state.

177. Terje Tvedt, Norway

The Nile in the Age of the British

(not ready yet)

178. Jorge Rodrigues, Spain/Belgium

1000 Years of Irrigation Law: the Development of a Sustainable Model in the Hydraulic System of the Segura River (South East Spain, Xth-XXth c.)

The irrigation system created around the city of Murcia, based on the control of the Segura River in South East Spain, is the result of a complex historical development. This development includes a unique group of rules that adapted peasants' customs and crystallized into a series of written Codes whose trajectory can be followed from the XIVth century till nowadays.

The creation of the Segura's capital city, Murcia, in 825 was the result of the will both of the central State to constitute a political and administrative centre for the lower basin, and of the inhabitants to assure its prosperity through an extended irrigated area. As a matter of fact, the existence of the City depends on the strict management of the river's water (for the area is one of the driest zones in Spain) and the effective defence against the periodical floods of the main river and the Guadalentín, a particularly dangerous tributary when adding its caudal to the Segura during the raining season.

The history of the irrigation system has been focused, on the one hand, on the design and implementation of strategies to avoid and/or to diminish the risk of catastrophic floods and on the other, the expansion of irrigation. The City and a number of powerful citizens and institutions with the ability to influence municipal decisions obtained new irrigated lands from draining marshlands. The extension of a complex drainage system preceded the installation of the irrigation network, and the drainage canals were connected to the general defence system against floods. This expansion process accelerated during the XVIth century and reached its maximum intensity in the XVIIth century. During the XIX century, a combination of State intervention and empowerment of communities resulted in an almost absolute control of the river, the end of the marshlands - including the endemic diseases associated with them, e.g. malaria, and the exploitation of all water resources for an irrigated/drained area that has reached its limits nowadays.

This paper assesses the model chosen to control effectively the river -a source of economic wealth and a permanent danger due to violent floods and diseases derived from the lack of appropriate drainage. This model is based on the assumption that cooperation among the irrigators is essential for the effective management of the hydraulic system, but also that a certain coercive element - coming from the irrigators themselves, the basis of the irrigation law, is necessary for the survival of the system. This is a model different from the classical Wittfogelian despotic structures of management, and also from the private organisations proposed as the solution for the "tragedy of the commons". Traditional principles coming from original customs and refined through different socio-economic and political frameworks have proven to create ideally a sustainable model of water management and an efficient strategy to solve conflicts between the components of the system.

179. Walter Dragoni, R. Burzigotti & L. Gervasi, Italy

The Role of Lake Trasimeno (Central Italy) in the History of Hydrology and Water Management.

Lake Trasimeno is located in Central Italy, in an area where water management begun a few centuries BC. The paper outlines the hydrological history of the lake during the last millennia, and describes the various attempts by man to control the lake's water level. Lake Trasimeno is a closed lake, with no natural outlets; at present it has an average surface area of about 122 km², and a maximum depth of less than 6 meters. The lake level varies considerably, and is strictly linked to meteorological and climatic conditions. The Etruscans or the Romans probably dug an underground outlet in order to control the water level, but the date and exact location of any such construction is unknown. During the Warm Medieval Period (roughly between 1000 and 1300 AD) the water level was rather low, but it rose again during the Little Ice Age (beginning around 1400 AD), and the lake flooded large areas used for agriculture.

In order to control the high water a new outlet tunnel was built in about 1420, and in around 1480 the basin of the lake was reduced by diverting two streams towards the nearby Val di Chiana swamps. These works did not succeed in controlling the floods, and thus at the end of the 19th century a modern and efficient outlet tunnel was built. For this reason, the lake level is at

least 2.5 meters lower today than the average level for the last four to five centuries. At present the climate in central Italy is changing again, with a decrease in the average rainfall and a slight increase in the average yearly temperature. Over the last sixty years this trend has caused a substantial lowering of the lake water level, which creates serious problems for the lake ecosystem and economy. In order to stabilize the level of the lake, in 1962 the streams diverted in 1480 were linked again to the lake, but the results have not been satisfactory: once again, as in the past, new actions are planned to cope with the new situation. The long history of the water management, projects and hydraulic works in the Trasimeno area has had a significant influence on the history of hydrology and hydraulics. Indeed, just as modern water science was being born, the problem of Lake Trasimeno initiated a centuries-long debate over the choice of the best actions to be carried out: for example, in about 1639 the hydrologist Benedetto Castelli gave the first description of a rain gauge in Europe while he was involved in the Trasimeno Lake problem.

180A. Jean-Yves Durand, France

Hydrogeology and water-dowsing: countercurrents and confluences

The history of hydrogeology has been well documented by historians of science and technology. Folk conceptions on groundwater have been studied by anthropologists, who have also paid some attention to water-dowsing. However, these bodies of research generally lack an attempt at a joint analysis that would try to bridge the gap between considerations on scientific and non-scientific knowledges. Trying to do so helps shedding some light on historical exchanges and communications between different means for groundwater detection. Recent ethnographic research in southern Europe shows, for instance, a surge of interest toward water-dowsing on the part of certain professional hydrogeologists (sometimes organized in associations) in spite of its lacking any scientific demonstration for its claims. This example also provides a way to relate such relatively circumscribed cultural shifts to socially much wider current changes in folk representations about water, fostering their better understanding by social sciences.

180B. Jean-Yves Durand, France

The anthropological study of water: a retrospective glance, and suggestions towards a renewed approach.

When focussing mainly on research within the Western world, a retrospective glance on the anthropological approach of water-related issues helps identifying a few aspects the discipline should pay more attention to: the political and sociotechnical dimensions of hydraulic facilities; water as a commodity for mass consumption; the present ramifications of ancient symbolic roots of water, especially when public understanding of hydrology mingle with ecological concerns. Such would allow for a better analysis of the way water is currently shifting from the status of *res nullius*, offered to the use of anyone, to that of a "collective heritage" which demands a risk-management type of approach by society. Should it deem important to scrutinize the implications of this evolution, anthropology could muster up its considerable know-how in localized research and thus take an active part in the definition of a renewed social science investigation on the topic of water.

181. Devarshi Kala Nath Shastry, India

Water in Indological Symbology

Right from the Vedic times, water has been a source of inspiration for the creative writers in India. In the Vedas, water has been seen (1) as one of the primal elements (Apas, as the first tangible element in the universe), (2) as a life-sustaining resource, the sources of which have been enumerated vividly, e.g. glaciers, oceans, skies (rain water), the earth (subsoil water, surface water), the dew etc. and (3) as denotant comparant (Upamaana).

Oceans, rivers, rains and perennial, ephemeral and transient streams have extensively served as the symbols and comparant images for different states of life, situations, moods and attributes of human nature. The study of such imagery can be of interest and pragmatic value. The oceans have always stood as a symbol of three attributes - depth, wealth and magnanimity. The sea never transcends bounds and serves as a symbol of discipline (Maryada). In ancient Indian literature,

Lord Rama has been compared to ocean (Samudra) by Valmiki for his sobriety and magnanimity. The ocean is also called a jewel-mine (Ratnakar) and a source of wealth. In the Vedas, the rivers stand for regular inflow of wealth and prosperity.

A mystic connection of water with the moon has been construed as an inexplicable bond between two distant entities attracted towards each other. The spring and neap tides in the seas are believed to be caused by the moon. These lunar phenomena serving as symbols have inspired many a poet over the millennia to create images of love and bonds of affection. On the imagery of spring tides, rising waters of the sea have been compared with the emotional upsurge. Different rivers of India have become symbols of different attributes -- most prominent being the Ganga, standing as a symbol of pristine purity and divine sanctity, Narmada of virginity, Sone of virility, etc.

Water as the purifier, has served as a symbol of firm resolve also: it is an invariable substance used in all religious resolves (Sankalpas), as also of oblation (Tarpana) -- being a thirst quencher. In the Hindu temples, after the final 'light offering', i.e. waving of lights around the images of the Lord, waving of water has also to be performed and a throwing (sprinkling) of water drops over the devout spectators attending the congregation is an essential part of the ceremony. Water has also been regarded as the 'destroyer'. The concept of cataclysm (Jala Pralaya), regarded as the last deluge brought about by the stormy and turbulent waters as the final cataclysm resulting into the end of the creation.

Various sayings, beliefs and images connected with water have been regulating the communal life of the Hindus in India. For example, after a child birth, the worship of water (Jalwa or Jal Poojan) is an essential ceremony, just as after a marriage and after a pilgrimage the worship of Ganga or a holy dip in its waters is considered to be an essential requirement. For oaths in the courts, Ganga water is used to vouch for honesty and truthfulness of statements. As a totem also, water has been used in the post Vedic India for cursing a person. The sages took some water in the palm and dropped it while pronouncing a curse on the sinner.

This paper attempts to discuss this new aspect and bring forth salient historical features of the concepts, beliefs, ceremonies and images related to water in the ancient Indian literature.

182. Isameldin Abakar Atiem & Ferhat Türkman, Turkey

Hydro-politics History of the Nile Basin: From disputes to solution.

In recent years, world trans-boundary watercourses are shaped with conflicts and disputes, internationally, and regionally these conflicts can be attributed in different viewpoints. Nile river is a trans-boundary river, and its hydrologic flow quantity regimes are highly variable from year to year. Consistently, this variability may not help water administrations in providing a reliable supplies to meet their demand, and thus, planners and managers in the basin water sectors are faced with the responsibilities of evaluating, conserving, and developing policies for water resources in their concerns. Nile basin encompasses ten states, most of these states are currently facing serious water scarcity conditions.

This paper assesses the river hydrology, geography, and summarizes the history of the basin disputes and treaties over Nile's water. The core concern of the paper is to be concentrated on the alternative supplies through the conservations of the upstream water losses, especial considerations are given to Sudd region losses. Thus forming a guidelines that may immediately a balance between supply and demand in the basin, and finally to harmonise states policies for establishing a greed regimes environment that may govern states actions.

183. Mark Cioc, USA

North America's Disappearing Wetlands: A New Look at the Migratory Bird Treaties of 1916 and 1936 between Canada, the U.S., and Mexico

This paper will examine the problems that currently beset bird protection in North America by looking at the political and economic considerations that resulted in the 1916 and 1936 treaties, still today the main mechanisms for bird conservation in the western hemisphere. The focus will be on the limits of the treaties as means for preserving habitat, especially coastal estuaries, floodplains, and interior wetlands. The main argument will be that the diplomats paid too much attention to hunting issues and not enough attention to issues of water habitat; as a consequence, the wetland drainage largely undermined the usefulness of the treaties.

184A. A.S. Solanki, India

Historical and Socio Economic Background of Inter State Traditional Drinking Water Management System in Dry Western Region of India.

The rainfall pattern in dry western region is quite erratic and uncertain. The dry Western region is included Rajasthan and a part of Gujrat S tate of India, where rainfall is extremely low and range between 200 to 300 mm per year. The formidable Thar and Kach dry region spread over 61 percent area of the state and covering 3.5 lakh square kilometers. It is a extremely different situation for population to survive specially for drinking water. The historical data has shown that the old Kings of the region constructed several alternative sources of drinking water like Bavri, tanka, nadi, talab's etc. Out of this "tanka" is very famous Kaccha structure made by every households in the region. This situation arisen due to the fact that the perennial rivers flow Rajasthan to Gujrat. The historical data showed that even Rajasthan people did not get drinking water. This also arisen interstate water conflicts. A detailed analysis was done to review the historical background of flow of river water (river - Bandi) from Rajasthan State to Gujrat and conflicts arisen, the solution suggested in terms of tanka and their economic impact at both state economy as well as at household levels.

Keyworlds: Drywesternregion, Thardesert, Tanka, Hitoirical background

184B. A.S. Solanki, India

Historical Perspective of Linking of Lakes and their Socio-Economic Impact in Sub-Numid Region of Rajastan, India

The ancient empires and Kings of beautiful "City of Lakes" Udaipur planed the water flow in such wisely that all lakes kept full of water whole year. In all, there are seven lakes in Udaipur city and all lakes are inter link to each other. A detailed historical and socio-economic analysis was done to review the linking of rivers and lakes and their socio economics impact on peoples of great Mawar region. The miscommunication and unplanned water distribution to the politically powerful people by irrigation officials, the situation has change now and all lakes are empty.

Key worlds: City of Lacks, Interlinking of canals, Powerfull people

185. Masood Samiee, Iran

Drought and Streamflow

The regression model is a relationship between dependent low flow characteristics and independent catchment and climatic variables. Several outhors delineate regions for some specific purpose. Wilshire (1986), Burn and Boorman (1993) and attempted to establish regions for regional flood analysis, Mimikou and Kamaki (1985) for regionalisation of FDCs; and Nikitin and Zemtsov (1386) and Gutinchenko and Sedov (1988) for lowflow regions.

Nathan and MC Mahon (1992) explicitly stated that regression models "... are in effect a "black_box solution to the problem..Where only inputs and outputs have any real significance. Basin and climate characteristic (independent variables) which are most commonly related to flow indices include: catchment area, Mean annual precipitation, Channel and or catchment slope, stream frequency and or density, percentage of lakes and forested areas, various soil and geology indices, Length of the main stream catchment shape and watershed perimeter, mean catchment elevation.

The lowest 30-days stream flow with the different periods of 12 stations in TEHRAN province in IRAN was estimated from watershed and climatic parameters. Because of the close relationship between low stream flow regimes and hydrological features, The model development first involved delimiting homogenous hydrological regions by using two-Step cluster analysis.

Of the parameters studied, area, watershed average Slope, geologic parameter and precipitation accounted for about 99/36 percentage of the spatial variability of 30-day low flows in a multiple-regression analysis. The study results reveal that the regional regression models developed in this study could be applied reasonably at ungaged sites.

Key words: low flow, regional analysis, ungaged sites.

186. Elmarie van der Schyff, South Africa

The Nationalisation of Waterrights: Deprivation or Expropriation? A South-African Perspective

South Africa's water law dispensation has changed dramatically with the promulgation of the National Water Act 36 of 1998. The previous distinction between public and private water has been abolished and the Minister of Water Affairs and Forestry has been appointed to act as trustee of the nation's water resources. Through the working of section 4(4), exclusive rights of water use, which were in force before 1998, were replaced by water allowances, granted in the discretion of the relevant authority. The key issue, which is investigated in this paper, is whether the state, through the provisions of the National Water Act, expropriated vested rights in property or whether such infringement merely constituted a deprivation.

The new concept of property in terms of section 25 of the Constitution of the Republic of South Africa and the distinction between deprivation and expropriation are examined. It is indicated that the concept of property in South African law has been extended to include not only ownership but also rights in property. Although no definition of property has been formulated in the Constitution, it appears from applicable authority, that this development in the law of property is supported by the Constitution and that the protection granted by the property clause will stretch as far as the inclusion of rights in property. It is for this reason that the existing water use rights, which were available to certain individuals in terms of the 1956 Water Act, can be classified as property.

Section 25(1) authorises the infringement of private property in certain defined instances. Despite the many academic works which define the difference between deprivation and expropriation as described in section 25(2), the Constitutional Court clarified this matter in *First National Bank of SA Ltd t/a Wesbank v Commissioner for the South African Revenue Services* 2002 7 BCLR 702 (CC). Expropriation is described as a sub-category of deprivation. Section 25(1) must thus be used as the starting point in all cases in which an investigation is conducted into the constitutional validity of an infringement of property. Only when it has been established that the requirements of section 25(1) have been complied with, is the question of whether deprivation constitutes expropriation, asked. The requirements for deprivation, expropriation and inverse condemnation are discussed with reference to applicable case law.

After the aim of the National Water Act was weighed up against the disadvantages which individuals suffer through the infringement of their vested rights, the conclusion was reached that the nation's need for sustainable water resources carries more weight than the individual's exclusive right of use of water. A constitutionally valid deprivation has thus occurred. Due to the fact that the state did not appropriate any rights in this process, the conclusion was reached that this provision does not amount to expropriation. It does however appear that the provisions of the National Water Act can give rise to inverse condemnation or constructive expropriation in specific circumstances.

Key words: National Water Act, Property, Expropriation, Deprivation, Inverse condemnation, Ownership

187A. Aysen Türkman & Ünal Ösis, Turkey

Historical Waterworks in Turkey

1. Hittite and Urartu Periods in Central & Eastern Anatolia (2nd Millenium BC - First half of 1st Millenium BC)

Turkey was at the crossroads of ancient civilizations and constitutes one of the world's leading open-air museums with respect to ancient water works, some of them being still in operation. The most ancient remains of waterworks in Turkey date back to the II. Millenium BC, the Hittite period in Central Anatolia, like the Karakuyu dam, the springwater collection chamber in Bogazkale, and some others. From the first half of the I. Millenium BC, the Urartu period in Eastern Anatolia, there exist various remains of dams and canals, some of them still in use like the 56 km long Samram canal, the dams at Kesis and Doni lakes.

2. Hellenistic, Roman, Early Byzantine Periods in Western & Southern Anatolia (Second half of the I. Millenium BC -End of the I. Millenium AD)

Remains of Hellenistic and especially Roman and early Byzantine waterworks in Western and Southern Turkey, from the second half of the I. Millenium BC to the first half of the I. Millenium AD, are very numerous and new discoveries add to the rich variety of them. Noteworthy are the 240 km long water conveyance system to Istanbul, the almost 100 km long system to Phocaea, up to 65 km long systems to Pergamon, up to 43 km long systems to Ephesus, others to Smyrna, Priene, Miletus, Alabanda, Laodicea, Xanthos, Patara, Perge, Aspendos, Selge, Side, Diocaeserea, Olba, Elaiussa, Samosata, Amaseia. They encompass aqueducts up to 40 m height, tunnels of over 2 m height, inverted siphons up to 190 m pressure, lead-, stone-, clay-pipes of various sizes, rock-cut and masonry canals, springwater collection chambers, city reservoirs, water distribution and sewerage networks. From the same period date also diversion tunnels like that in Seleuceia Pieria, tunnel-like superstructures on creeks like those in Pergamon and Nysa, with diameters up to 9 m; dams like the 10 m high Çavdarhisar, 16 m high Örukaya and some others. Covered and open cisterns in Istanbul, with side lengths in the order of 150 to 250 m, are extraordinary examples of antique cisterns.

3. Seljukide & Ottoman Periods in Anatolia & Thrace (10. - early 20. Centuries)

There are certain remains from the Seljukide period in Central and Eastern Anatolia, from 10. to 13. centuries, like the water conveyance canal to a mill in Çermik, the Sahip Ata irrigation canals in Konya, irrigation systems in Eregli and elsewhere. Among the remains of waterworks from the Ottoman period in Turkey, 14 to 20 centuries, those for Istanbul and Edirne deserve particular interest. The Halkali conveyance systems to Istanbul, constructed in the period of 1450's to 1750's, consist of 16 systems with a total length of 130 km, including the 50 km long Süleymaniye by Sinan the Architect in 1550's. The 50 km long Taslimüsellim system to Edirne, is also considered as a work of Sinan, dating from 1530's. The 55 km long Kirkçesme system to Istanbul from 1560's, is one of the masterworks of Sinan, with four major aqueducts (Uzun, Egri, Maglova, Güzelce) up to 35 m height and 700 m length. The Taksim water conveyance to Istanbul from 1730's and the Üsküdar systems east of Bosphorus from 16. to 19. centuries are also noteworthy. In the period of 1620 to 1839, the Kirkçesme system is supported by four, the Taksim system by three dams, with heights up to 17 m and crest lengths up to 104 m. All these dams, Kirkçesme and Taksim systems as well as the Taslimüsellim-Edirne system are for the large part still in operation. The diversion of Gediz river to prevent the closure of the Izmir bay in late 19. century; Beysehir-Çumra irrigation south of Konya in early 20. century; the generation of the first electricity in Turkey in 1902 at the Tarsus hydroelectric scheme are other interesting achievements at the down of the Ottoman Empire.

188. Katsumi Matsuoka, Japan

Emerging Principles of Public Participation in Water Management: Institutional Implications, Responses, and Challenges.

For the last decade, international society has become more aware of the importance of public participation in the field of water law and management, and in tackling water crisis. The involvement of all stakeholders in the planning process of large infrastructure projects like dams has the advantage of enabling them to contribute ideas to maximize the benefit of such projects, while considering alternatives for financial and economic performance. The notion of participatory approach has gained its place in various instruments such as international declarations, statements, and treaties. Whereas the previous regimes of water management tended to be prescriptive in character with an emphasis on a top-down approach, the new paradigm of water management leans more towards a bottom-up, or multilateral collective approach.

This principle of public participation is a factor of sustainable development, an element of integrated water resource management, a guide of effective water governance, and a symbol of environmental justice. The concept of public participation encompasses various factors in context of water management. It ranges from better communication, consultative mechanisms, dispute settlement, water information networks, access to information, sharing responsibility, and ensuring public participation in decision making, to promote public awareness of the importance of water among all levels of stakeholders. We may analyze what is called public participation into different aspects in terms of its ends, means, and forms. We may also make use of it as a standard for evaluating how far democratic process is achieved in water management.

As the concept of public participation develops as a norm and becomes a prevailing idea in national and international water law, there arises a need to formalize the principle of public participation. The study will identify this principle in the context of water management in terms of legal implications. This also covers normative reflections in national and international water law, focusing on its development over the decades and providing a discussion for the future.

189. Prabhath Patabendi, Sri Lanka

Hydraulic civilization in Sri Lanka - A case study of "Sigiriya Water Gardens 477-495 AD" a World Heritage site

Historians studying the rise and fall of Sri Lanka's ancient hydraulic civilization have marveled at its engineering technology and water resource management. The establishment of forests and construction of ponds, reservoirs and irrigation systems were considered great meritorious acts in accordance with popular Buddhism, the faith of the leaders and the large majority of people in Sri Lanka. Our history is full of achievements of kings who contributed to the development of water resources. Since the first century AD kings built numerous reservoirs and irrigation systems. An indigenous expertise developed over the centuries which appears to have been called upon by other countries of South Asia.

Sigiriya now a world heritage site and regarded as the 8th wonders of the world was created by King Kasyapa who reigned between 477-495 AD. The summit of this almost inaccessible rock is 180 m (600 ft) above the surrounding jungle and was the setting for a courtly paradise of elegant pavilions amid gardens and pools. The rock was transformed into a recumbent lion by the addition of a brick-built head and foreparts of which only the paws remain. The rock's natural defences were augmented by broad moats and stone perimeter walls. In the event of an enemy approach, the outer moat was built so as to flood the entire area between the two moats.

Sigiriya water garden was created 5 centuries before those at Angkor in Cambodia or Mughal gardens in India. The central island would have been occupied by a large pavilion. The terraced gardens slope down to the boulder gardens and then to the geometrically laid out water gardens, with running water and fountains, pools and ponds, aquatic flowers and birds, and tropical trees. The entire water garden is in a walled enclosure. The miniature water garden was discovered not long ago. It has winding waterways, shallow reflecting pools, co belled watercourses, marbled floors and an intricate layer of tiled roof buildings. Adjacent to this is a central island surrounded by

four L-shaped water pools. These pools appear to have been used as bathing pools. These had polished walls, flights of steps and surrounding terraces - similar to a modern-day swimming pool. There are fountains fed by water under gravitational pressure from the artificial Sigiriya Lake. Symmetrically perforated limestone plates fashion their spouts. These fountains operate in rainy weather even today. An octagonal pool is set at the transition point from the water gardens to the boulder gardens. It is surrounded by a wide terrace, which follows its shape. A gigantic boulder almost the height of a six-story building shelters the pool.

This paper will analyze the rise and fall of Sri Lanka's hydraulic civilization with special preference to engineering technology applied to create Sigiriya Water Garden.

190. George E. Gruen, USA

The History of Turkish Plans to Export Water

This paper will analyze the history and current status of Turkish plans to export water to other riparian countries on the Mediterranean as well as to more distant Middle Eastern countries on the Arabian Peninsula. The most ambitious of these was the late President Turgut Ozal's 1986 "Peace Water Pipeline," a \$21 billion project to bring water from the Seyhan and Ceyhan rivers via two pipelines to supply major cities in Syria, Jordan, Israel and the Arab Gulf States. We will examine the economic, political and technical reasons why this project has not been implemented. A more limited proposal to construct a shorter pipeline from the Seyhan or Ceyhan to convey Turkish water to Syria, Jordan, Israel and the Palestinian territories - estimated to cost \$ 5 Billion, has also been shelved. A major reason has been Syrian refusal to join the Multilateral Working Group on Middle East Water Resources established by the October 1991 Madrid Peace Conference. Syria has argued that multilateral cooperation must wait until Israel agrees to total withdrawal from the water-rich Golan Heights. Ankara strongly objected to a Syrian proposal in 1996 that Turkey provide Syria with additional quantities of water from the Euphrates to compensate it for assuring a continuing supply to Israel from Jordan River headwaters on the Golan.

However, Turkey has recently had more success in some more modest water export schemes. Turkey has concluded a 10-year contract with Nordic Water Supply to convey a minimum of 3.6 million tons of water annually from the Dragon River on the southern coast of Anatolia to Guzelyurt in the Turkish Republic of Northern Cyprus (TRNC) by giant plastic balloons pulled by tugboats. There is also a not yet funded proposal by Turkey's ALARKO Company to construct an underwater pipeline from Turkey to Cyprus with an annual capacity of 75 million cubic meters (MCM). While Turkish and TRNC officials have expressed their readiness to provide some of this water to the Greek part of the island, Cyprus Republic President Clerides told the author that he favored desalination as a solution because of concerns that Turkey could use Greek Cypriote dependence on this water as an instrument of political pressure. We will attempt to assess whether the recent signs of improvement in personal contacts between Greek and Turkish Cypriotes as well as the expected admission of Cyprus to the European Union in May 2004, will improve the prospects for Turkish-Greek water resources cooperation.

Finally, we will review the history and current status of Turkey's latest "Peace Water Project," a \$122 million facility on the Manavgat River near Antalya designed to export some 180 MCM of water annually. After years of negotiations, in August 2002 Israeli Prime Minister Ariel Sharon reached an agreement with visiting Turkish Minister of Energy and Natural Resources Zeki Cakan under which Israel has agreed to purchase 50 million cubic meters of water annually from the Manavgat River for 20 years. However, despite several Israeli delegations going to Turkey to negotiate the details, no final agreement had yet been published as of the end of June 2003. The issues of price of the water, the means of transportation, by tanker, plastic balloons or pipeline and the construction of the necessary installations in Israel remain to be worked out. Meanwhile Israel has also begun construction of desalination plants and Israel's Ministry of Finance has criticized the Manavgat water import scheme as too expensive. (We will follow this debate and include updated information in the Alexandria Conference paper.) It should be noted that officials in Jordan and the Palestinian territories, which face severe and growing water shortages, have also expressed interest in Turkish water, assuming that the price is reduced or subsidized by international aid agencies. Ankara proudly views the Manavgat "Peace Water Project" as a tangible contribution by Turkey to the Arab-Israel peace process.

191. B. Al-Salman & H. Ghoneim, Kuwait

Historical Perspective of Water Supply in Kuwait

Groundwater is a precious water source everywhere in the world, particularly in Kuwait, which is characterized by extremely arid conditions. This paper is presenting a historical perspective of water supply, ground water production and consumption.

Prior to 1925, rain water and shallow wells were the main sources of water. Between 1925 and 1951, Water was imported from Shatt Al-Arab, Iraq, to meet increasing demands. In 1951 a public water supply service was established and managed by the State, with seawater desalination and underground brackish water as the principal sources of water. In 1951 Kuwait oil company started installation of a small desalination plant in Mina Al-Ahmadi brought the utilization of water from shallow wells and Shatt Al-Arab to an end and opened a new era in modern water supply.

The accidental discovery in May 1960 of fresh water at Raudhatain gave additional impetus to initiate groundwater investigations. The Parsons Corporation, U.S.A., was engaged to investigate this area and develop a production well field. Another underground water fresh water field was developed at Umm Al-Aish almost in the same time.

To meet the increasing demand for water, new distillation facilities were progressively installed. The impressive development of this source is represented by the year (1986) production of 175,997.7 million l/yr (38714 million gal/yr) and maximum consumption of 582.8 million l/d, (128.2 million gal/d) compared with 1,118.3 million l/yr (246 million gal/yr) and 3.36 million l/d (0.8 million gal/d) in 1954 (MEW, 1987).

Realizing the importance of the rational management of the groundwater resources of the country, the Kuwait government is sparing no effort in the search for alternative sources of water to supplement the groundwater resources in an attempt to prolong the life of this important entity. One of the important sources of water that can be considered in this regards is wastewater. This source of water can be utilized efficiently to meet the growing demand on water in the country. In Kuwait, there are presently 3 sewage treatment plants.

192. Felix Chami, Tanzania

East Africans Stricture of the Nile Treaty: What Happened to Their Water Share?

The Nile treaty of 1929 and revised in 1959 was an understanding between the British Government, Egypt and Sudan over the riparian rights of the Nile River. The British Government in that treaty represented its colonial subjects in Kenya, the Uganda protectorate and the Tanganyika trusteeship whose landscapes and lakes formed the main sources of the Nile. The treaty prohibited any other party in the Nile Basin, apart from Egypt and Sudan, from using the waters for major projects including irrigation.

Since then, in the early 1960s, the British subjects in East Africa became independent. Subsequent to the independence episode came needs to use the waters of the Lake Victoria and the Nile for the development purposes. The three independent countries came to recognize what their colonial master had left behind as a Nile Treaty, which does not give them any chance to use their waters for any serious development project. Efforts to understand the treaty and question it were hindered, before 1990s, by the colonialist East African community, which still carried on with the colonial interest, and later on by the breakdown of it, which led each territory to pursue their own mundane idiosyncrasies.

Following the re-establishment of the East African community, by the East Africans themselves, and after the launching of their new joint parliament, many issues of joint interest have cropped up one being that of the Nile Treaty. East Africans want to use the resources available to them for their own development including the Nile Basin. The look stupid that while everyone uses his/her resources - oil, minerals and waters - they can not use some of their key resources, even to

produce food for subsistence, because at one time an enslaver and colonizer refused them to do so.

This paper explores the nature of the new debate in the East African and national parliaments about this new topical issue. The media and the general public have aired their views about the Nile Treaty. This paper also uses the debate to predict about the future of the treaty in the likelihood that the three governments of Uganda, Kenya and Tanzania may fail to continue honoring it.

193. Dawa Zangmo, Bhutan

Bhutan Water History

Bhutan has been consistently following a conservation-centred development policy. This policy has been inherited from the wisdom of forefathers who knew that ensuring the integrity of forests, rivers and soil was vital to their survival in the mountainous environment. Their wisdom, which has been synthesized into our modern development philosophy, has been crucial in maintaining a good natural resource base. 72.5% of the country is under forest. This good vegetation cover with a fair spatial distribution of precipitation on a mountainous topography has endowed the country with rich water resources. The average flow draining the country's area is estimated at 1600 m³/s. This puts the per capita availability of water per annum at 75000m³, which is the highest in the region. The mountainous topography, with altitudes varying from 100 to over 7500 metres above sea level, drained by four major rivers with their numerous tributaries has given the country a high potential for hydropower development.

However, Bhutan cannot afford to be complacent. The country is confronted with localized and seasonal water shortages for drinking and agricultural purposes. Today only 78% of the population has access to safe drinking water and only about 12.5% of the arable land is irrigated. The fluctuation between lean season and monsoon season flows is on the rise leading to sub-optimal utilization of generating capacity of hydro power plants. The increasing sediment load in rivers is decreasing the expected output and economic life of the hydropower plants. These phenomena are to a certain degree caused by the uneven distribution of precipitation over the mountainous terrain. Floods and landslides are two major threats that emanate from such a setting.

The pressure on the water resources is mounting due to competing demands from different users. In the past, water was mainly used for domestic and agricultural purposes. The domestic water demand is increasing due to changing lifestyles caused by socio-economic development. The water use for agriculture is expected to increase due to its intensification to keep pace with food demand of a growing population. New demands are emerging from other sub-sectors such as hydropower and other industries. Urbanisation has become a key issue that has serious impact on both water demand and quality.

WATER VISION FOR BHUTAN: "Water will continue to be available in abundance to pursue the socio-economic development in Bhutan. Present and future generations of Bhutanese people will have assured access to adequate, safe and affordable water to maintain and enhance the quality of their lives".

194. Zeydan, Bakenaz A., Egypt

The Nile River Studies - State of the Art

The Nile is one of the world's great rivers. For millennia, this unique waterway has nourished varied livelihoods, an array of ecosystems, and a rich diversity of cultures. As the world's longest river, it traverses nearly 6,700 kilometers, covering more than 35 degrees of latitude and draining an area of over 3 million square kilometers; one tenth of Africa's total land mass. It is a basin of varied landscapes, with high mountains, tropical forests, woodlands, lakes, savannas, wetlands, arid lands, and deserts, culminating in a vast delta on the Mediterranean Sea. It is generally agreed that the Nile has several sources. The principle streams are the White Nile, which begins in the Great Lakes region of Central Africa; and the Blue Nile (Abbay) and the Atbara (Tekeze), both

flowing from the Abyssinian highlands. The most distant source is the Kagera River, which winds its way through Burundi, Rwanda, Tanzania and Uganda into Lake Victoria.

The Nile River is shared by ten countries; Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The basin contains outstanding environmental assets, such as Lake Victoria, the second largest fresh water body by area in the world, and the vast wetlands of the Sudd. It also serves as home to an estimated 160 million people within the boundaries of the basin, while about twice that number, roughly 300 million, live within the ten countries that share and depend on Nile waters.

Despite the extraordinary natural endowments and rich cultural history of the Nile Basin, its people face considerable challenges. Today, the basin is characterized by poverty, political instability, rapid population growth, and environmental degradation. Four of the Nile riparian countries are among the world's ten poorest, with per capita incomes in the range of USD 100-200 per year. Population is expected to double within the next 25 years, placing additional strain on scarce water and other natural resources. In a historic step, the riparian countries jointly established a Cooperative Framework to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources.

The present study highlights the state of the art in the River Basin studies that are related to historical, social, economical, geographical, hydrological, water rights, and water management aspects.

195. Kabbashi, N. A, Fakhru'l-Razi Ahmadun, and K.B. Ramachandran

Composting of Sewage Sludge in a Horizontal Drum Bioreactor

In this work, a medium scale horizontal drum bioreactor was designed and fabricated for composting sewage sludge. The sludge was collected from different treatment plants in Malaysia, which is considered as the clean sewage system in the world, and amended with sawdust at different ratios, before composting. As a result, the initial C/N ratio increased effectively from about 7.0 to around 18.0 after the addition of sawdust. Three different types of microorganisms namely *P.Chrysosporium*, *Trichoderma harzianum*, and *Mucor hiemalis* isolated by UPM, Malaysia were used to inoculate the compost mixture to study their effect on the composting process.

Key Words: Sludge, Compost, Horizontal drum bioreactor

196. Bhattarai, Lok P., Nepal

Hierarchies of Water Control in Nepal Himalayas: A Reflection from Political and Cultural History of State Formation

Nepal Himalayas is one of the major geographic segments in the upper catchments of Indo-Gangetic plains. For that reason, it has been remaining mainly as a 'cultural watershed' of the civilization of the Indo-Gangetic plains of the south than the Tibet in the north. However, Nepal Himalayas has its distinct historical experiences than other parts of Himalays in course of the evolution of cultural and political history. In this article, I depict how 'water', despite being a 'god-gift' product, deserves special cultural metaphoric meanings in the ecological history of this part of Himalayas. I will discuss the history of water use in light of the history of the evolution and diffusion of irrigation technology and the water management organization in course of the process of Nepali state formation.

This article focuses on depicting how, on the one hand, the Hindu notion of 'personhood', hierarchies of the roles of different actors in cosmic arrangement, worldview and, on the other, the politics of inclusion and exclusion, property right and the economic arrangement of production and distribution were nicely tailored in the logical framework of symbolic meaning of water. The article also illustrates how 'water' was taken as a marker of social boundary, which ensued as an arrangement of exclusion and inclusion of caste, ethnicity, sex and region in the larger structure of property regime. Secondly, this article discuss how the cultural arrangement for the hierarchies of water control has been ridiculously destroyed in the changed context of social transformation while state already went in the direction of secular democratic regime abolishing the olden arrangement.

This article will also tend to precipitate the issue in the current context of social conflict and insurgency in Nepal Himalayas.

197. Magdy Hefny, Egypt

Towards A Framework for Localizing COMSET's Global Ethical Guidelines in Egypt and Africa Region

In 1998, the World Commission on the ethics of Scientific Knowledge and Technology (COMSET) was established. A resolution, to that effect, passed at the 29th session of UNESCO's General Conference. Special attention has been given by COMSET to freshwater along other vital areas of energy and information technology, for which three working groups were established to investigate and research into their field, within specific mandate.

By the time of convening the forthcoming IWHA 3rd Conference in Cairo in December 2003, five years have elapsed. And there is a rich and varied body of discussions and documentation, emanated from intensive work of the working groups and panels of eminent scholars and experts

The aim of this paper is to highlight the work of the Sub-Commission on Water, and suggests a framework for localizing such valuable water ethics initiative on the national and regional Africa level. It is timely and of special importance, to have a candid discussion and better reflection, on issues involved in building such a framework for localizing COMSET's global ethical guidelines in Egypt and Africa Region, for which this conference is best suited.

H.E. Mrs. Vigdis Finnbogadottir, Chairperson of COMSET, has aptly explained that "ethics can be simply defined as an attempt to evaluate choices from essentially human perspective" (COMSET, proceedings, Oslo, Norway, April 1990). She has guided the work of the Sub-Commission on Water by putting several questions to investigate, inter alia,

- how to balance the right to water as a prerequisite for life with the right of ownership,
- how to agree on preventing contamination or selfish exploitation of a shared basic resource,
- access to freshwater has increasingly been identified as a major potential threat to world peace in this century.

In Aswan, Egypt, the Water Sub-Commission under the patronage of H.E. Mrs Susan Mubarak, the First Lady of Egypt and Member of the COMSET met in November, 2000. The theme of the Conference was entitled: "Towards Ethical Guidelines for the Use of Freshwater". The Report made reference to aspects of water as an ethical issue and concluded with guiding principles on the global level on: consuming water, protecting water, and distributing water. The question, here, in this paper is how best such ethical guidelines could be initiated and applied on the national and regional Africa level.

It is encouraging that, "Global Research and Ethical Network Embracing Water" (RENEW) has been created. And node points of RENEW started to take shape in some geographic regions. The program for such a node would embrace all aspects of water, and have "Bottom-Up" education / communication functions, as well as "Top-Down" high level research aspects, with industry participation. RENEW also includes best examples of ethical practices in all aspects of freshwater use. These activities are of special interest to the node point for Africa region and its future programme of work.

In October, 2002 an International Conference was held in "Bibliotheca Alexandrina" on Ethical and Social Responsibilities in Science and Technology. A special Committee addressed, among other issues, ethics on freshwater and emphasized the importance of initiating and localizing the guiding principles for water as an ethical issue.

These developments and issues raised in the paper ranges from conceptualizing and building a framework for localizing the Global Freshwater Guidelines, to issues of capacity building, processes of social learning through better participation of different water research canter, education, water suppliers, water regulators, industrial and agricultural users, organizations concerned with information and exchange and dissemination.

It well emphasized by Mr. Koichiro Matsuura, the Director General of UNESCO, in his message on World Water Day 2000:

"The challenge we face... is to set in motion a dynamic that will make this the century of world water security. Water has long been too low on the public policy agenda... We need to take a constructive approach to water; it is an essential, shared resource; it should be treated as foremost priority in every community from local to the global"

198. Erlend Eidsvik, Norway

Semiotics of a Sacred River. Signs and Meaning in the Holy River Bagmati

The holy river Bagmati in Kathmandu, Nepal, has for the last few decades become severe polluted. As the river flows through the densely populated capital, it is gradually reduced into a drain for industrial and domestic waste.

Even though the physical quality of the river has deteriorated, the ritual significance seems to be maintained, at least by some strata in the population. For others, the religious dimension has decreased, or even vanished. The meanings ascribed the river Bagmati in modern Kathmandu are stated in voices of ambiguity.

This paper intends to reveal the ambiguous meanings ascribed the Bagmati River among the population in Kathmandu today.

Identifying the different signs ascribed the Bagmati and further implement the signs in semiotic models is the analytical approach in this paper. A semiotic model illuminates the relation between an object, a sign and an agent (or interpretant, as Peirce states it). Hence is such a model a suitable model for studies in geography: An agent, embedded in society, gives the object (in the nature) a sign, which is a cultural expression based upon the agents experience with the object in the nature.

The paper further discusses the process of mentalising the river, the process of establishing the river as a mental concept more than a physical river. The image of the primordial, clean and divine river is re-established, emphasising the river as a national icon, a manifestation of the legacy of Nepal in a religious, geographical and historical context. This process unveils different sets of metaphors, which again is derived from the signs ascribed the river Bagmati.

199. Edwynna Harris, Australia

Sustainable Management of Australia's Murray River 1905 to 1984, a Case of Government Failure?

The Murray River is a river in crisis. Blue-green algae blooms, the extinction of native flora and fauna, erosion of riparian areas, and salinity have all come to threaten the continued productive use of this river system. As Australia's largest source of fresh, surface water producing \$10 billion in agricultural crops annually the environmental problems faced by the Murray River have substantial economic, social and political ramifications for the nation. Economically, the costs of current environmental damage have been estimated in the millions of dollars. For instance, it is predicted that by 2015, the cost of lost production due to degradation will increase to \$95 million per annum (MDBMC, 1988). This will have a substantial impact on the nation's GDP. Socially, the very survival of communities that have historically relied on exploitation of Murray River water to support regional industries, such as dairying is being threatened. Politically, the acceptability of both state and federal government water management policies for stakeholders will exert considerable influence over the outcome of future elections.

In light of these issues, this paper considers the impact of historical institutions used to manage Murray River in promoting degradation. With 70 per cent of water being extracted from the Murray used for irrigation purposes, this paper focuses on the allocation and pricing of water in Victoria, Australia's rural irrigation areas over the bulk of the twentieth century*). The main contention is that the catalyst for many of the problems noted above was centralised government management that resulted in distortion of economic incentives at the user level preventing individuals from internalising the full costs and benefits of their resource use. This in turn, limited the possibilities

for a sustainable outcome. As such, it presents empirical evidence to support the contention that in natural resource management, just as markets can fail, so too can governments.

For much of the twentieth century, a statutory corporation referred to as the State Rivers and Water Supply Commission (SRWSC) was responsible for all areas of water management in Victoria. This management regime promoted degradation due to three main factors. First, the creation of a compulsory water charge which meant farmers had to pay for water regardless of whether they used it or not. This in turn, encouraged over use. Second, the compulsory charge was set at such a low level (as evidenced in subsidies and the absorption of capital costs by the government) that it stifled the application of more efficient irrigation technology to limit degradation because farmers did not face the opportunity or social costs of their investment decisions relating to water use, in turn encouraging over use and inefficiencies to prevail. Third, the absence of tradable property rights that resulted in the price of water being based on politically determined values that favoured vote accumulation in the place of efficiency. The gerrymandering of political boundaries ensured that political decisions regarding water pricing supported the development of rural areas above all else. In addition, lack of tradability trapped farmers in an inflexible institutional arrangement in which they substantially undervalued the good they exploited because they had no objective valuation of their subjective utility. All these factors combined to promote degradation of the river system by users who were trapped in inefficient irrigated farming. As a result of these factors, this institutional arrangement severely limited the possibilities for good environmental stewardship and sustainable use.

*) It is important to note here that two other states in Australia used Murray River water for irrigation over this time period, South Australia and New South Wales. However, Victoria was the first state to introduce full-scale irrigation and the other two states used this institutional structure as a model for their irrigation management. Hence, it is assumed that the nature of their water management systems mirrored that of Victoria and, as a result, would have contributed to degradation in a similar way.

200. Susana Galera Rodrigo, Spain

Water Planning and Land-use Planning in the European Law

From a political science point of view, spatial planning could be considered as an integrated part of a comprehensive societal policy. In this context, city and regional planning, as a procedure to manage social development in spatial terms, makes arrangements for future use of land by public and private owners. In other words, territorial planning is a sort of political process by which a balance is sought between all interest involved -public and private- to resolve conflicting demands on space.

On the other hand, from a legal point of view, land-use planning is empowered by the recognition of its regulatory nature in European legal system. Consequently, public bodies and citizens are binding by its determinations. Within the political science, similar considerations could be done in relation to water planning, which are to be considered as societal policy instrument and as an arrangement for future use of this natural resource, being the case of spatial planning.

Particularly in Southern and Western Europe, hydrologic planning is a policy tool specially important, since environmental problems in this European territory needs middle and long term policy instruments to be solved. In these areas, water scarcity is an increasing problem, which is particularly remarkable in zones with a semi-arid climate. Eutrophication of river and lakes, over-exploitation and salt intrusion in aquifers are the main features of poor water quality in semi-arid areas. It has to be considered that around 80% of the European Union's population lives in cities and towns, where environmental problems -specially water scarcity- are increasing due to several factors, i.e., increases in per capita consumption as a result of increased standards of living with increased use of water-using appliances, as well the water demand for irrigation in a framework where the evolution of irrigated land is expected to go up.

Furthermore, tourism is undoubtedly an additional factor of greatest pressure on resources in southern European countries: tourism makes an important contribution to the economies of most Mediterranean countries, as is the case in Portugal, Spain France and Greece. The increase in water demand by tourism is an important pressure in the areas where it concentrates, particularly

because these areas already have problems of water shortages. Some of these areas face an added pressure from irrigation, which uses most of the water during the summer when the population doubles, thus enhancing the impact of a drought.

Urban areas create environmental problems due to the high density of activities that take place there. Consequently, the role of land-use planning and management is crucial. This covers a wide range of decisions, usually made at local and regional level, determining the character and intensity of land uses and activities which may often have a major impact on environmental conditions.

However, the legal consideration of hydrological planning is weaker than land-use ones. Under a legal point of view, an urban plan can ignore future management of water resources included in a hydrological plan, because its general provisions are not empowered by binding effects. Until present, political decisions about land-use remains at national level, due that European Union has not received competences in this subject by its member States.

Nevertheless, European environmental community law increasingly includes some provisions which involves urban planning to achieve this goal. According to this recent community regulation, land use planning decision should reconcile development with environmental and social assets; this requires that the planning system is adequately coordinated by previous coordination of natural resources legal regulation's. The Community Directive on Strategic Environmental Assessment (SEA) aim to ensure that the environmental implication of planned infrastructure projects and planning are properly addressed, as well that the environmental considerations are better integrated into planning decisions. Beyond this, the Community can only play a role of encouraging and promoting effective planning and adequate policies at the local and regional levels. Other community programmes are able to have some role in this aim, such Common Agricultural Policy, which encourage environmentally positive land management by ways of agri-environment programmes -having among its priorities to rationalize and to reduce the irrigation water demand-.

It is the purpose of our inquiry to analyze how far the new European regulation are able to go, considering the fact that political decision about territorial management remains at the state level. However, an important part of environmental European competences can have an important impact on member State's domestic decisions, determining part of the content of their decisions concerning territory. Above all, the goal of this contribution is to emphasize the consideration of hydrological planning provisions as a determining input concerning any land-use decision.

201. Navuth Chay, Cambodia/Japan

Traditional water usage in central part of Cambodia: The case of Sambo village Kampong Thom Province

1- Introduction

This presentation is a part of my master thesis titling "Society and Culture in a Village of Central Cambodia- a seek for sustainable agricultural development". In this presentation I am going to introduce the Traditional water usage in central part of Cambodia the case of Sambo village Kampong Thom Province. The reason that leads me to choose this village as my study area because the area just located next to the Sambo Prey Kuk monument (a pre-angkorian monument and wellknown as the city of 7 century). Recently Sambo Prey Kuh is the target of the tourism industry. While the war ravaged the rest of the nation, the areas lay untouched: the region is now the largest, most pristine in Cambodia if comparing with other areas in Cambodia. Both local and national authority of Cambodia is seeking the ways to attract the tourist into this area, evidently the reconstruction of high way, and the agreement of renting this site to a famous local company SOKIMEX (as Angkor area) to be invested. Different from the Angkor region, the Sambo Prey Kuk region is a freshly and newly region with less or very rare, if one want to understand and develop this area. The purpose of the study is to record and understand the traditional water usage which been used by the villager in this region and making a readily suited recommendation for the further development planning. As the method of the study, I will use an intensive participation investigation, observation and randomly interview some key person such as the monks, ACHAR and people in the Sambo village.

2- Overview of present situation of Sambo village

Sambo village is one of the old villages located 35 km from Kampong Thom town and just approximately 100 meters from Sambo Prey Kuk monuments. In the south of this village there is a longest river in Cambodia "Stoeung Sen". Today the village becomes one of the most rapidly change village in the region. This village lives 1002 villager, the average number of member in a family 5 persons. The main income for their living is agriculture: transplanting is the primary type of rice cultivation, direct planting (shifting agriculture) is the secondary type and I can say this second type can be served as a security type of food production. Broadcasting is the last rice cultivation mode.

3- Traditional water use

There is several old water bodies can be seen from the aerial photo including pond, lake, canal. In the north of the village located an old water tank which still people use it as a daily water supply during dry season. In the far south lay a river "Stoeung Sen" which is flow from the mountain in the north of Cambodia. Recent year, a NGO initiated to dig a water tank in the south North of village.

In the south of the village located another 3 ponds. 1 of these three still function as a reserving water body for rice planting if the dam which was built long time ago and has been repaired several times during Khmer rouge and in the recent year by a NGOS. Another one far south west of the village, nowadays the people change it into the rice field during the dry season. But most part of the land surrounding this pond is occupied by the people from another village.

In general, no any scientific standard of irrigation systems can be seen in the area, but several local irrigation systems can be seen in the field. Those systems are the cutting passes water flow, which always can be found in the north (serve as an inflow passage) and south (serve as an outflow passage) of each rice fields. During the rice-planting season (raining season) the ox-cart tract have another function: main water flow, so this tract has a dual functions, transportation and main water distribution canal.

There is no existing of water user group or water management law. There no any institutions nor NGOs nor project nor development agencies advices the farmer. But the farmers have a mutual agreement in water management for their rice field.

4- Analysis and discussion

The water usage in Sambo village can be represented as a model, which initiated by the people and very efficiency model for farmer in this region but not in other part of Cambodia where there is different condition of ecological systems. While at the present most of the agriculture development strategy are set their method for increasing the rice yield by recommending the farmer to widen their rice field by making the rice field into a larger rectangular form and leveling the rice field as flat as possible, but here the rice field of Sambo village is a case of exceptions, making easier for water management.

Conclusion:

The traditional mutual water usage plays a vital role in the livelihood of the Sambo village. This type of water management must be maintained and improved to meet the future grow of population and the threat of the wave of "modernization".

202. Loay J. Froukh, Palestinian Admin. Area

Transboundary Groundwater Resources of the West Bank

The political boundaries between the Palestinian and Israelis make the water issues critical and sensitive. Groundwater is the primary source for the Palestinian in the West Bank. Although, there are many studies on the shared surface resources (Jordan River Basin), there are few studies on the groundwater shared resources between the Palestinians and Israelis. There are three primary groundwater basins underlying the West Bank (Eastern, Northeastern and Western Basins). Both the Northeastern and Western basins are shared between Israelis and Palestinians. The Palestinians have a limited access to the Northeastern Basin and strictly limited access to the Western Basin. In addition to the quantity of available water resources, the quality of water is emerging as a critical issue. Threats to ground water quality include disposal of untreated wastewater, increasing salinity due to agricultural activities and intrusion of native groundwater of poor quality. Widespread use of herbicides and pesticides also represent a threat to drinking water supplies. The Declaration of Principles, signed in Washington D.C in 1993, was a major step toward

resolution of the political conflict between the Israelis and Palestinians. However, the water issue is part of the final status negotiations, which still unresolved. As resolution to political conflict is pursued, it is clear that water resources management issues remain at the forefront because of the transboundary nature of the hydrologic regime. Cooperative management on the technical level appears to be the only alternative to further conflict and degradation of the region's scarce water resources. This article will study the impact of the transboundary resources on both sides and explore some of the most significant groundwater management issues facing both the Palestinians and Israelis.

200. Susana Galera Rodrigo, Spain

Water Planning and Land-use Planning in the European Law

From a political science point of view, spatial planning could be considered as an integrated part of a comprehensive societal policy. In this context, city and regional planning, as a procedure to manage social development in spatial terms, makes arrangements for future use of land by public and private owners. In other words, territorial planning is a sort of political process by which a balance is sought between all interest involved -public and private- to resolve conflicting demands on space.

On the other hand, from a legal point of view, land-use planning is empowered by the recognition of its regulatory nature in European legal system. Consequently, public bodies and citizens are binding by its determinations. Within the political science, similar considerations could be done in relation to water planning, which are to be considered as societal policy instrument and as an arrangement for future use of this natural resource, being the case of spatial planning.

Particularly in Southern and Western Europe, hydrologic planning is a policy tool specially important, since environmental problems in this European territory needs middle and long term policy instruments to be solved. In these areas, water scarcity is an increasing problem, which is particularly remarkable in zones with a semi-arid climate. Eutrophication of river and lakes, over-exploitation and salt intrusion in aquifers are the main features of poor water quality in semi-arid areas. It has to be considered that around 80% of the European Union's population lives in cities and towns, where environmental problems -specially water scarcity- are increasing due to several factors, i.e., increases in per capita consumption as a result of increased standards of living with increased use of water-using appliances, as well the water demand for irrigation in a framework where the evolution of irrigated land is expected to go up.

Furthermore, tourism is undoubtedly an additional factor of greatest pressure on resources in southern European countries: tourism makes an important contribution to the economies of most Mediterranean countries, as is the case in Portugal, Spain France and Greece. The increase in water demand by tourism is an important pressure in the areas where it concentrates, particularly because these areas already have problems of water shortages. Some of this areas face an added pressure from irrigation, which uses most of the water during the summer when the population doubles, thus enhancing the impact of a drought.

Urban areas create environmental problems due to the high density of activities that take place there. Consequently, the role of land-use planning and management is crucial. This covers a wide range of decisions, usually made at local and regional level, determining the character and intensity of land uses and activities which may often have a major impact on environmental conditions.

However, the legal consideration of hydrological planning is weaker than land-use ones. Under a legal point of view, an urban plan can ignore future management of water resources included in a hydrological plan, because its general provisions are not empowered by binding effects. Until present, political decisions about land-use remains at national level, due that European Union has not received competences in this subject by its member States.

Nevertheless, European environmental community law increasingly includes some provisions which involves urban planning to achieve this goal. According to this recent

community regulation, land use planning decision should reconcile development with environmental and social assets; this requires that the planning system is adequately coordinated by previous coordination of natural resources legal regulation's. The Community Directive on Strategic Environmental Assessment (SEA) aim to ensure that the environmental implication of planned infrastructure projects and planning are properly addressed, as well that the environmental considerations are better integrated into planning decisions. Beyond this, the Community can only play a role of encouraging and promoting effective planning and adequate policies at the local and regional levels. Other community programmes are able to have some role in this aim, such Common Agricultural Policy, which encourage environmentally positive land management by ways of agri-environment programmes -having among its priorities to rationalize and to reduce the irrigation water demand-.

It is the purpose of our inquire to analyze how far the new European regulation are able to go, considering the fact that political decision about territorial management remains at the state level. However, an important part of environmental European competences can have an important impact on member State's domestic decisions, determining part of the content of their decisions concerning territory. Above all, the goal of this contribution is to emphasize the consideration of hydrological planning provisions as a determining input concerning any land-use decision.

190. George E. Gruen, USA

The History of Turkish Plans to Export Water

This paper will analyze the history and current status of Turkish plans to export water to other riparian countries on the Mediterranean as well as to more distant Middle Eastern countries on the Arabian Peninsula. The most ambitious of these was the late President Turgut Ozal's 1986 "Peace Water Pipeline," a \$21 billion project to bring water from the Seyhan and Ceyhan rivers via two pipelines to supply major cities in Syria, Jordan, Israel and the Arab Gulf States. We will examine the economic, political and technical reasons why this project has not been implemented. A more limited proposal to construct a shorter pipeline from the Seyhan or Ceyhan to convey Turkish water to Syria, Jordan, Israel and the Palestinian territories - estimated to cost \$ 5 Billion, has also been shelved. A major reason has been Syrian refusal to join the Multilateral Working Group on Middle East Water Resources established by the October 1991 Madrid Peace Conference. Syria has argued that multilateral cooperation must wait until Israel agrees to total withdrawal from the water-rich Golan Heights. Ankara strongly objected to a Syrian proposal in 1996 that Turkey provide Syria with additional quantities of water from the Euphrates to compensate it for assuring a continuing supply to Israel from Jordan River headwaters on the Golan.

However, Turkey has recently had more success in some more modest water export schemes. Turkey has concluded a 10-year contract with Nordic Water Supply to convey a minimum of 3.6 million tons of water annually from the Dragon River on the southern coast of Anatolia to Guzelyurt in the Turkish Republic of Northern Cyprus (TRNC) by giant plastic balloons pulled by tugboats. There is also a not yet funded proposal by Turkey's ALARKO Company to construct an underwater pipeline from Turkey to Cyprus with an annual capacity of 75 million cubic meters (MCM). While Turkish and TRNC officials have expressed their readiness to provide some of this water to the Greek part of the island, Cyprus Republic President Clerides told the author that he favored desalination as a solution because of concerns that Turkey could use Greek Cypriote dependence on this water as an instrument of political pressure. We will attempt to assess whether the recent signs of improvement in personal contacts between Greek and Turkish Cypriotes as well as the expected admission of Cyprus to the European Union in May 2004, will improve the prospects for Turkish-Greek water resources cooperation.

Finally, we will review the history and current status of Turkey's latest "Peace Water Project," a \$122 million facility on the Manavgat River near Antalya designed to export some 180 MCM of water annually. After years of negotiations, in August 2002 Israeli Prime Minister Ariel Sharon reached an agreement with visiting Turkish Minister of Energy and Natural Resources Zeki Cakan under which Israel has agreed to purchase 50 million cubic meters of water annually from the

Manavgat River for 20 years. However, despite several Israeli delegations going to Turkey to negotiate the details, no final agreement had yet been published as of the end of June 2003. The issues of price of the water, the means of transportation, by tanker, plastic balloons or pipeline and the construction of the necessary installations in Israel remain to be worked out. Meanwhile Israel has also begun construction of desalination plants and Israel's Ministry of Finance has criticized the Manavgat water import scheme as too expensive. (We will follow this debate and include updated information in the Alexandria Conference paper.) It should be noted that officials in Jordan and the Palestinian territories, which face severe and growing water shortages, have also expressed interest in Turkish water, assuming that the price is reduced or subsidized by international aid agencies. Ankara proudly views the Manavgat "Peace Water Project" as a tangible contribution by Turkey to the Arab-Israeli peace process.

024. Roger D. Hansen, USA

Strawberry Valley Project: A Comparison with non-Federal Irrigation Projects Constructed during the Same Era

The Strawberry Valley Project was the first Federal water project constructed in the State of Utah, located in the western United States of America. Started in 1907, it was also one of the U.S. Bureau of Reclamation's earliest construction efforts. While much has been written about the project (Larson, 1955; Alexander, 1971; Merrill, Snyder, and Anderson, 1982; MacKay, 1982; Mayhew, 1992; etc.), there is still a need to place the project in its historical context.

In the early twentieth century, central Utah was a hotbed of water developmental activity. The Utah State Engineer (1913, p. 177) described the activities during the period 1910-20 as "the most extensive development of irrigation resources of any like period in the history of Utah." This paper will compare the Strawberry Valley Project to five other Utah projects: Hatchtown, Piute, Delta, Elberta, and Mosida. They can be roughly divided into three general categories: (1) State-sponsored projects, (2) Carey Act projects, and (3) private developments.

The State of Utah constructed two dams in the Sevier River Basin: Hatchtown and Piute. The State then sought to sell irrigable land downstream from the reservoirs. Near the origins of the Sevier River at Hatchtown, the State made an unsuccessful attempt to construct a dam. Unfortunately, the dam failed in 1914 and the project died. The Piute Dam and the 65-mile-long Piute Canal were constructed to irrigate lands in the central Sevier River Basin. While features of the Piute Project are still in place, the project is considerably less smaller than was originally intended.

The Carey Act of 1894 was an attempt to distribute Federal lands to homesteaders. The Act authorized the distribution of 4 million acres of public land. An important condition was that lands could not be sold unless they were serviced by irrigation projects. While the states administered the distribution of the inexpensive Federal land, the water systems under the Carey Act were financed by private-sector capitalists. Only one of Utah's Carey Act projects, the project of the Delta Land and Water Company in Utah's west desert, was successfully developed.

Private irrigation developments were also constructed during this period; these projects were financed by entrepreneurs from inside and outside the State. Typical of these developments were Mosida and Elberta, two projects located around the southern tip of Utah Lake. Both were envisioned as small farms interspersed with orchards. The Elberta project is still in operation, but the facilities of the Mosida development have faded into history.

Each of the 5 non-Federal projects had its promotional literature, appealing to rugged individualism and independence. No matter who the promoter, they all over-promised. At Elberta, salesmen stated that "it is not uncommon for a single apple tree to yield a larger income per year than the choicest acre of farm land in Iowa or Illinois." Most of marketing was aimed at prospective buyers in the Midwestern United States. The results of these over-promises were frequently tragic, and proved the absolute necessity for reliable water development in order to make a living off the land in Utah. In contrast to the State and private developments, the Strawberry Valley Project was successful because it had the expertise and finances of the Federal government behind it.

199. Edwyna Harris, Australia

Sustainable Management of Australia's Murray River 1905 to 1984, a Case of Government Failure?

The Murray River is a river in crisis. Blue-green algae blooms, the extinction of native flora and fauna, erosion of riparian areas, and salinity have all come to threaten the continued productive use of this river system. As Australia's largest source of fresh, surface water producing \$10 billion in agricultural crops annually the environmental problems faced by the Murray River have substantial economic, social and political ramifications for the nation. Economically, the costs of current environmental damage have been estimated in the millions of dollars. For instance, it is predicted that by 2015, the cost of lost production due to degradation will increase to \$95 million per annum (MDBMC, 1988). This will have a substantial impact on the nation's GDP. Socially, the very survival of communities that have historically relied on exploitation of Murray River water to support regional industries, such as dairying is being threatened. Politically, the acceptability of both state and federal government water management policies for stakeholders will exert considerable influence over the outcome of future elections.

In light of these issues, this paper considers the impact of historical institutions used to manage Murray River in promoting degradation. With 70 per cent of water being extracted from the Murray used for irrigation purposes, this paper focuses on the allocation and pricing of water in Victoria, Australia's rural irrigation areas over the bulk of the twentieth century*). The main contention is that the catalyst for many of the problems noted above was centralised government management that resulted in distortion of economic incentives at the user level preventing individuals from internalising the full costs and benefits of their resource use. This in turn, limited the possibilities for a sustainable outcome. As such, it presents empirical evidence to support the contention that in natural resource management, just as markets can fail, so too can governments.

For much of the twentieth century, a statutory corporation referred to as the State Rivers and Water Supply Commission (SRWSC) was responsible for all areas of water management in Victoria. This management regime promoted degradation due to three main factors. First, the creation of a compulsory water charge which meant farmers had to pay for water regardless of whether they used it or not. This in turn, encouraged over use. Second, the compulsory charge was set at such a low level (as evidenced in subsidies and the absorption of capital costs by the government) that it stifled the application of more efficient irrigation technology to limit degradation because farmers did not face the opportunity or social costs of their investment decisions relating to water use, in turn encouraging over use and inefficiencies to prevail. Third, the absence of tradable property rights that resulted in the price of water being based on politically determined values that favoured vote accumulation in the place of efficiency. The gerrymandering of political boundaries ensured that political decisions regarding water pricing supported the development of rural areas above all else. In addition, lack of tradability trapped farmers in an inflexible institutional arrangement in which they substantially undervalued the good they exploited because they had no objective valuation of their subjective utility. All these factors combined to promote degradation of the river system by users who were trapped in inefficient irrigated farming. As a result of these factors, this institutional arrangement severely limited the possibilities for good environmental stewardship and sustainable use.

**) It is important to note here that two other states in Australia used Murray River water for irrigation over this time period, South Australia and New South Wales. However, Victoria was the first state to introduce full-scale irrigation and the other two states used this institutional structure as a model for their irrigation management. Hence, it is assumed that the nature of their water management systems mirrored that of Victoria and, as a result, would have contributed to degradation in a similar way.*

023. Ute Hasenoehrl, Germany

Conflicts Between Economic and Conservation Interests Concerning Hydroelectric Power Plants. The Case of the River Lech (Germany)

Efforts for water regulation, straightening of rivers and the construction of hydroelectric power plants were intensified in Western Germany after the Second World War in order to solve energy problems, make shipping easier and increase agricultural productivity. While channelization and regulation of rivers were conducted throughout the country, activities to utilise waterpower for energy production concentrated on the southern part of Germany where flow velocity of rivers is highest. The proposed paper focuses on the federal state (Land) of Bavaria whose efforts to make use of the "white coal" far surpassed those of the other German states and where protests against the destruction of scenic landscapes for economic reasons were most determined.

Bavaria's electricity supply had relied on the import of thermal energy from the lignite regions in Eastern Germany. When the import of brown coal had stopped after the Second World War, Bavaria - with only scarce deposits of coal of its own - initiated a vast energy program based mostly on hydroelectric power. While the construction of hydroelectric power plants at rivers already partly regulated and industrialised like the Main in northern Bavaria met almost no resistance, the violation of scenic white water rivers in the foothills of the Alps caused strong protests from conservationists, especially after the immediate energy shortage had already been solved. One of the most controversial projects has been the regulation of the river Lech for energy production. The dispute whether or not to alternate and therefore possibly destroy some of the most beautiful and scientifically interesting parts of the river for economic reasons protracted for over two decades. The arguments brought forward here from both the energy company BAWAG - responsible for building and maintaining the power plants at the Lech - and conservationists alike are representative for similar conflicts on the subject of water regulation: The industry emphasised economical necessities, technical difficulties of alternatives and the validity of existing contracts. On the other hand, conservationists referred to the singular beauty of the landscape, the need to preserve rare species, alternative methods to produce energy and the priority of natural values over short-lived business interests. The case of the river Lech differs from other conflicts, however, in its fierceness. While the industry tried to achieve their goals through threats, bribery and illegal building activities, conservationists attempted to use public opinion as a means of exerting pressure. Acting uncoordinatedly in most cases, different conservationists groups and scientific institutions here united their efforts ('Notgemeinschaft Oberer Lech'). As a result, the conflict of the river Lech became known beyond the boundaries of Bavaria causing international attention.

The proposed paper aims to further analyse why the case of river Lech developed into a trial of strength between economic and conservation interests, which considerations motivated the actors and which methods they chose to realise their intentions.

070. Khondker Iftekhar Iqbal, Bangladesh

The Water Regime, Economy and Society in the Eastern Bengal Delta, c. 1840-1943

My paper seeks to situate ecology within the matrix of indigenous societal change. Set in the nineteenth-century Eastern Bengal Delta (roughly today's Bangladesh), it will focus on how society and ecology, particularly the water-regime, informed each other as they were transformed.

The Bengal Delta which represents fresh water eco-system is consisted of three delta-heads formed by the three major rivers of the Himalayan ranges: the Ganges, the Meghna and the Brahmaputra. These rivers, as they lose the precipitous speed while entering the plain of Bengal, begin to deposit silt brought down from upcountry until they finally carry it to the sea. It is estimated that some 40,000 millions of cubic feet of solid matter are deposited in the deltaic plane or thrown out to the sea every year in this process. At the same time, the ocean currents also find themselves impeded by the heavy outflow from the rivers, and in their turn drop down the burden of sand. Thus a double process of land-making goes on amidst the mutual confrontation of silt-laden rivers and

sand-carrying sea. It is estimated that in the riparian district of Bakarganj alone, the natural 'aggradation' increased the land area by 18 per cent or 1399 square kilometers per year.

This extraordinary ecological circumstance led to a new relationship between the state and the members of the agrarian society. In the new alluvial lands the government opted for directly engaging with the enterprising peasants rather than with the zamindars or the landlords who were favoured by the government in the older tracts of the Bengal Delta. Now those who could be actively employed in the reclamation of the new lands in the hazardous riparian zone and in the production of exportable crops found themselves at the centre of the shift. Intensive peasantization followed. In most cases this was reflected by the offer of favourable tenural arrangements to the cultivators, which included perpetual occupancy rights and other advantages related to land. The ecological regime thus helped to bring about remarkable changes in the social and economic structure in the region. The state of economic performance was reflected, among other things, in the bulk of internal and external trade and corresponding increase of cash flow into the Delta, growing labour price, absence of famine and lower degree of indebtedness. Social dynamics were represented by a broader scale of income generation, independent mentality, growing sense of self-respect and justice and an interest in education.

My paper will focus on such historical transition in the Eastern Bengal Delta that was so deeply connected with the fluvial actions of its extravagant water system in the nineteenth century.

031. D. Janaki, India

Reinventing Decision-making: Women in Water Management Practices

The first woman came from a Lake, the mountain was her father and the river her mother. Legends also show that women had closer relations with water than men. The connection between women and water through the knowledge on gender, nature and culture is a scholarship which is of contemporary significance in the field of various development issues like women in development, women and development and mainstreaming which includes Decision making and Institutional forms. They have concern in empowering and in capacity-building for decision making and participation in the institution- building among women in irrigation. These are various contemporary Gender strategies in managing water related practices. The core issue, in this, is in bringing women from periphery to centre in the decision-making process- a founding concern of dimension. This contemporary issue of feminist perspectives of women and water cannot be wished away from this dimension. The idea behind looking into the dimensions of women and water to REINVENT the decision-making women in water management practices is the core of this research paper over which this abstract is based only point to be pondered over to draw lessons to reconstruct or to enrich the contemporary gender strategies in water management practices.

Irrigation being the most basic input for agricultural development, it has been the accepted policy of the Government to extend irrigation facilities in phases to all water shortage areas. The ultimate irrigation potential of country through major and medium irrigation project alone is 58.45 million hectare. It is essential to involve women in various water related activities to overcome various social and environmental problems in its proper development and management.

Uniformly research has demonstrated that in most agricultural systems and activities women have a wider variety of roles than men and that except for ploughing which is generally done by men. Most other activities weeding, transplanting, sowing, watering, etc. are done by women, that in terms of time women work longer and harder and often receive less wages. [sec. chen. FAO, 1991]. There is another reality which is often masked that 87% of all economically active women derive their livelihood from the agricultural sector, and that 48% of self employed farmers are women. In fact, this is the sector where women's role as unpaid labour. In productive activities is most prominent and is responsible for conferring on women a non-working status. But their contribution is often made invisible by statistical biases, work on their own farms, wages etc. In fact basing its claim on a dictionary definition of farmers a study by the FAO stated that, indeed most farmers in India are women. [FAO 1991].

Women's traditional role in collection and providing water is well established. Not only have they been the principle carriers of water, but it is they who decided which water source to use for different purposes, how much water to use and how to transport, store and draw it. According to a study commissioned by UNICEF[NDWM 1990] even currently the principle collectors of water in India household are women, usually between the ages 15-35 years collecting about 192 litres of water per day for each average household of seven members clearly, in their role as providers of water, women suffer the impact of depleting water resources most severely. The amount of time, women spend in carrying water various across regions and can be as high as four hours a day. [GOI 1988 a]

Women play a central role in provision, management and safe guarding water though women have seldom been reflected in Institutional arrangements for the development and management of water resources. They are rarely involved in strategic decision-making process regarding water management. But in the management of water in terms of timing and other dimensions the involvement of women is indirect and restricted. It shows that the legal norms in determining the title of the land to make members of the society appear to be the major factor in restricting the women in water management in irrigation. Women are perceived as beneficiaries of water projects rather than partners in planning or managing them (MENTION THE SOURCE). Be it drinking water or irrigation for agriculture, they are merely representing rather than involving in the decision making. They have the role of collection, storage and maintenance of water but not the role in the management of water security.

Mainstreaming women is a new argument and rethinking and development. It proposes to bring women from the margin to the centre of the main development programmes and of the institution t-m building that deal with development. Development of women in India confirms that they have accepted change in the tertiary and secondary fields like dress, education, occupation and social behaviour. But the core values such as attachment to tradition, devotion to husband, responsibility for domestic harmony and progress, religious values, social customs and manners, etc. have not changed or at least have changed imperceptibly. With such framework, an examination of women's role in the decision-making process particularly in water management practice requires greater attention

Mainstreaming women in the decision making process is an ideology of women's movement where there is greater homogeneity. The transformative practice of women in converting the ideology into practice/action runs into rough as the ideal spectrum of homogeneity gets blurred into heterogeneity. There are enough evidences to demonstrate this transition from homogeneity into heterogeneity along with the transition from idea into action whenever the women movement is active. The same will be searched in the water management practices and institution building through the framework of the decision-making process of women. This is the basic thrust of the abstract through a case study of Water management practices in Tamilnadu, India.

141. Robert Kabumbuli, Uganda

Conflict Dynamics in Water Management: A View from Kampala's Wetland Slums

Background:

A doctoral study in Makerere University investigates how the dynamics of conflict are influencing, and how they can influence, the management of the wetlands to reduce water contamination. The wetlands in the catchment of Lake Victoria's Murchison Bay are the case study. It is based on the understanding that wetlands should filter the water that drains into the Bay from Kampala City, and on the concern that the Bay is the main source of water for the city. These wetlands have been encroached upon and are under real threat from human activity.

For this presentation, emphasis is laid on the impacts of slum settlements in and on the fringes of the wetland system that is also home to the Nakivubo Channel. This channel forms the main drainage system flowing southeast of the city into Lake Victoria.

Objectives:

The study solicits the views of the poor slum dwellers that are in the closest touch with the wetlands, and whose lives are influenced by the wetlands on a daily basis. What are their views on (a) the importance of wetlands (b) whether and how wetlands should be protected (c) the

relevance of the law on wetlands. How do their views conflict with official policy on wetlands, and with what implications for Kampala's water system?

Methods:

Qualitative and quantitative methods have been used; 250 questionnaires were administered in three slum communities to households selected because (a) they are resident (b) own property (c) practice agriculture (d) practice brick-making in the wetland. In-depth interviews and focus group discussions have been held. Interviews were also held with policy agencies and NGOs.

Results:

Preliminary data analysis shows that although people know about the law on wetlands, they continue to encroach on wetlands because of mainly poverty. Their views on wetland protection are influenced by their intimate and dependency relationship with the wetlands. Conflicts are many among the communities because of (a) poor or absence of sanitary facilities, the biggest source of water contamination (b) uncontrolled disposal of garbage within and from outside of the community (c) constant floods which destroy property and endanger life (d) lack of well-defined ownership rights over land.

Conclusion:

Conflict of perception, interests and rights over wetlands between the various stakeholders has functional implications for the management of water. An understanding of the nature and sources of such conflict will contribute to the formulation of policy on water.

176. Maria Kaika, UK

The Water Framework Directive: a new directive for a changing social, political and economic European framework.

The paper examines the intricate process of developing the European Union's Water Framework Directive. It sees the Directive as a response to recent economic, political and social changes related to water management, including the shift from government to governance, the liberalisation of water markets and the emergence of a new set of institutions, actors, etc. and their respective relations (i.e., social capital). The paper focuses on the key points of disagreement between the Council of Ministers and the European Parliament that threatened to prevent the Directive from being materialised and interprets this controversy as the culmination of conflicting interests between different actors at the local, national and European levels. Finally, it asserts the increasingly important role of the nation state in the decision making and implementation of the Directive and sets this against recent arguments about the death of the state.

1026. Bong W. Kang, South Korea

**Large-scale Reservoir Construction and Political Centralization:
A Case Study in Ancient Korea**

The relationship between centralized authority and construction of irrigation systems has been a major research topic in both anthropology and archaeology for many decades. One of the focal points of this issue is whether large-scale irrigation works were a cause or a result of political centralization. Some scholars have argued that construction of such projects played a critical role for the emergence of centralized, bureaucratic social structures. On the other hand, many scholars have argued that large-scale irrigation works were constructed after a centralized government emerged, and otherwise relatively small-scale cooperative irrigation works were independently managed by local people for their own benefit without intervention of centralized political authority. The major purpose of this paper is to argue that large-scale reservoirs were constructed after the appearance of centralized political organization at least in the case of the Silla Kingdom in ancient Korea.

This paper will investigate a reservoir probably constructed either in 476 or 536 A.D. in the Silla Kingdom, which existed between the first century B.C. and 936 in southern Korea. The reservoir still exists and is being utilized by local rice farmers as a reliable water source. In 1968, a

commemoration stele was discovered near the reservoir by a local history interest group. This stele, which is inscribed with nearly 100 Chinese characters, provides valuable sources of information concerning the overall reservoir construction project. The epigraphic record briefly describes the time period the reservoir was constructed, titles of the government officials who supervised and directed the project, and their real names with their hometowns. It also mentions the fact that 7000 laborers from two different communities located near the reservoir were drafted for at least 60 days. Thus, based on the contents of the stele and other documentary sources and epigraphic records available, it is possible to investigate the relationship between political centralization and construction of large-scale reservoirs in the process of the development of the Silla Kingdom in ancient Korea. This research will provide a case for answering the general question concerning the role of irrigation works in association with the emergence of complex societies.

076. Tapio Katko, Petri Juuti & Pekka Pietilä, Finland

Historical perspectives of public-private cooperation in water services

The paper aims at showing that public-private partnerships, recently presented and lobbied as something unique, new and innovative, has historical roots. In the mid of the 19th century most of the western nations, if not all of them, started to develop urban water and sewerage services by privately owned companies or private operators. In most countries the utilities were fairly soon taken over by municipalities.

Only in France private operators, such as Vivendi, or the former the Compagnie Générale des Eaux have survived and expanded since 1853. This is largely due to the fact that even today there are some 36 000 municipalities in France. Thus managing water services by single municipality-owned utilities is out of question. There are several other policy instruments that have favoured and still favour the use of private operators.

Another more recent case is the full privatisation of regional water and sewage works in England and Wales in 1989. The paper shows, how the privatisation was preceded by purposeful policy changes that did not allow public utilities to operate on sustainable basis. However, the experiences of this privatization is faced with increasing critics and it is possible that sooner or later they will be returned to public ownership. The most recent trend is that a few large private companies have expanded their activities worldwide supported by several international agencies.

Considering the long-term perspectives and more recent experiences in the water sector, the paper concludes that instead of promoting private ownership or long-term private operator contracts the issue of public-private partnerships should be seen in a wider context. The justification of these services based on health, environmental, land use and democracy as well as the need for wider institutional development should not be forgotten in favour of neo-classical economics that are not able to explain the complexity of these services.

153. Irene J. Klaver, USA

"Whose Water is it Anyway?": Public Good and Private Property on the Edwards Aquifer in Texas

Critical to the resolution of water conflicts is a common understanding of property rights. Distinctions between common property and private property when applied to water rights and management policies tend to limit discussion of alternative, and potentially more productive ways of approaching water rights. The authors in this paper draw upon recent efforts in Texas to address the management and use of water from a common aquifer that spans seven counties in the south central part of the state. When water law was first codified in 1840, the Republic of Texas recognized the existing surface water rights granted under Spanish law. Yet, the Legislature also adopted English Common Law and with it English riparian water law. This law applied to the vast land grants that were awarded to private landholders.

Yet it is groundwater that accounts for sixty percent of Texas water needs. At the turn of the century the Texas Supreme Court in *Houston & T. C. Ry. v. East* (1904) ruled that the owner of the overlying land can pump and use the water with few restrictions, whatever the impact on adjacent landowners or more distant water users. While the *East* case has been somewhat modified, the "rule of capture" was recently reaffirmed in *Bart Sipriano, Harold Fain, and Doris Fain, Petitioners v. Great Spring Waters of America, Inc. a/k/a Ozarka Natural Spring Water Co.* (1998). The Justices were reluctant to find in favor of the plaintiffs, farmers in Van Zant County who charged that the Ozarka Natural Spring Water Company had lowered the water table and dried up their wells. The Justices in a split decision ruled in favor of Ozarka, but the majority argued that the legislature and not the judiciary should reform Texas Water Law. The authors argue that current conceptualizations found in water rights discourse could actually limit meaningful legislative reform, and offer alternative ways of address rights and use of the common resource.

096. Anuradha Kumar, India

The Story of Nagpur's Floundering Lakes: Reviving Traditional Methods through Citizens' Effort.

Nagpur located in the heart of India is one of the country's fastest growing cities. It is the second largest city in the Vidarbha region of Maharashtra, a state in western India, and is a growing industrial and commercial hub. For the last three decades, Nagpur and the area around it have suffered from acute water shortage. The region habitually receives less rainfall but owing to the rapid growth of population, water supplies have fallen short.

Traditional sources of water, Nagpur' lakes and water bodies, are now in a state of decline. The city was set up more than 300 years ago by the tribal Gond rulers, later it came under the Peshwas (ministers of the Maratha rulers, Shivaji and his descendants) and the British. Its location at the foothills of a chain of mountain ranges and its 12 lakes that peppered the city made it an ideal site. The lakes were well managed and a well-oiled administrative system ensured the lakes were maintained well to supply the needs of the civic population and the armies the rulers maintained. Some of the lakes had other uses - as a source of supply to pleasure gardens and also served religious purposes too. Later, when Nagpur became an important textile centre under the British, its lakes helped sustain this thriving industry.

Following independence, the maintenance of traditional water bodies has seen a decline. Besides the increase in population, the system of administration too moved away from decentralized, people centred management to a more centralised, large-irrigation project centred one. Dams and irrigation projects were sanctioned, and bureaucracy, unfamiliar with local history and traditional systems moved into positions of authority. The result has been a decline in traditional modes of water supply. Worse, the construction boom in the last decade has seen the lakes come under increasing threat. The Pandharabodi lake is now walled over with cement.

However, a spirited civilian effort is on to save the lakes. NGOs, environment action groups and specialists, civic leaders are now working together to arouse awareness to save the lakes, especially the Sonegaon and the Sakkardara lakes, from disappearing altogether. The ambitious National Biodiversity Plan has focussed on Nagpur as an area of strategic concern.

My paper would look at the history behind the management of Nagpur's lakes, administration and local management, the changes that led to its decline and now the spirited civic effort that is on to rescue them from ultimate oblivion.

109. Raoudha Makkaoui, France

Management of Water Resources and Property Rights. A Historical Approach

Water is an essential component of the history of civilizations. Men have always wanted to ensure the availability and control of water resources. Thus, the history of water is part of our social history.

Water resources cannot be classified in the property rights context. The various forms of water require to classify them by characteristics: running waters (rivers and navigable waters) remain a

public property (res publica); stagnant waters (waters sources, wells and spring waters) are linked to the depths of these waters and hence belong to their owner's private lands (res nullius). Once the water reaches the ground, the land owner has the right of using and depositing of the water under his property.

The water-appropriation question has been raised in all civilizations and translated into customs and traditions. In our modern societies, this issue is studied through the concept new of the "common heritage". The purpose of our paper is to study the management policy of waters resources applied today through the study of evolution of water's rights

Our intervention consist of two parts: in the first part, we try to summarize the evolution of the property rights of water from a historical view. First, we will study water property rights in the roman constitution. Then, we will focus on the evolution of the key aspects of water property right of water in France (in the feudal and post-revolutionary constitution).

In the second part, we study the recent changes in water property rights. We will start by examining the changes in water management policies since the eighties, from a state-dominated policy to a decentralised policy. We will notice that since conference held in Stockholm in 1972 and conference of Rio in 1992, governments had to strengthen their responsibilities. The emergence of the concept of sustainable development has led to adopt new policy measures: taking into consideration needs in water and preserving the ecological balance of water resources. Then, we will use the example of the concept of "common heritage" in the French context. We will see how this concept leads to the approach of sustainable development and the way it has been modified to be part of the European Union legislation.

188. Katsumi Matsuoka, Japan

Emerging Principles of Public Participation in Water Management: Institutional Implications, Responses, and Challenges.

For the last decade, international society has become more aware of the importance of public participation in the field of water law and management, and in tackling water crisis. The involvement of all stakeholders in the planning process of large infrastructure projects like dams has the advantage of enabling them to contribute ideas to maximize the benefit of such projects, while considering alternatives for financial and economic performance. The notion of participatory approach has gained its place in various instruments such as international declarations, statements, and treaties. Whereas the previous regimes of water management tended to be prescriptive in character with an emphasis on a top-down approach, the new paradigm of water management leans more towards a bottom-up, or multilateral collective approach.

This principle of public participation is a factor of sustainable development, an element of integrated water resource management, a guide of effective water governance, and a symbol of environmental justice. The concept of public participation encompasses various factors in context of water management. It ranges from better communication, consultative mechanisms, dispute settlement, water information networks, access to information, sharing responsibility, and ensuring public participation in decision making, to promote public awareness of the importance of water among all levels of stakeholders. We may analyze what is called public participation into different aspects in terms of its ends, means, and forms. We may also make use of it as a standard for evaluating how far democratic process is achieved in water management.

As the concept of public participation develops as a norm and becomes a prevailing idea in national and international water law, there arises a need to formalize the principle of public participation. The study will identify this principle in the context of water management in terms of legal implications. This also covers normative reflections in national and international water law, focusing on its development over the decades and providing a discussion for the future.

125. Francois Molle, Sri Lanka

The "Closure" of River Basins: Trajectories and Societal Responses

The development of societies is to a large extent dependent upon their resource-base, notably water resources. Access to water depends on available technology and engineering feats such as river diversion structures, canals and dams. As growing human pressure on water resources brings actual water use closer to potential ceilings, societies usually respond by adopting conservation measures and by reallocating water towards more beneficial uses.

This paper reviews various conceptualizations found in the literature of development of river basins over time. A typology of societal responses to water scarcity is then presented. It emphasizes the need to distinguish between responses devised by the state at the global level and those of individual farmers and small groups or communities. Whether these responses occur sequentially is examined by referring to several empirical situations which illustrate that a multilinear evolutionist framework can only crudely represent the specific historical evolutions and patterns that are encountered. A few elements which appear to be crucial in shaping responses, are then singled out, including the nature of the state and state/citizenry relationships, the impact of "shock events", the nature of the political economy and the conditions of agrarian change.

074. Daniel Murillo Licea, Mexico

Relocalizations of Chinantecs and Mazatecs for the Construction of Dams in the Papaloapan River Basin, Mexico: A Retrospective Vision of the Involved Actors.

In the year of 1954 concludes the construction of the Miguel Aleman dam (or Temascal) in the mexican state of Oaxaca; that occasion 20,000 mazatecs were moved from its towns, to the lower Papaloapan basin. Years later, between the years of 1974 and 1988, 26,000 chinantecs were moved of its towns by the construction of the Cerro de Oro dam. The areas of relocalization aimed towards Uxpanapa, Los Naranjos and in other zones of the state of Veracruz like Ignacio de la Llave, Isla, Playa Vicente, Rodriguez Clara and Xochiapa. In the third relocalization the definitive zones were populated in the municipalities of: Ignacio de la Llave, Tlaxicoyac, Playa Vicente, Villa J. Azueta, Isla, Rodriguez Clara, San Andrés Tuxtla, Santiago Tuxtla, San Juan Evangelista, Tlacotalpan and Cosamaloapan.

The cultural shock of the settlers of the flooded zones was also an element in game: the earth that had belonged to the mazatecs and chinantecs ancestors and in where many of the settlers had been born were left. Despoliation also was one of symbolic-cultural character.

The situation of the relocated ones is a special subject and that deserves quick attention. It is a conflicting center in two-way traffic: in one, conflicts by the land can appear, since still there are cases of confusion in the possession of estates and parcels and a demand for water for irrigation land. On the other hand, the cultural confrontation between relocated and the aged settlers of some zones present specific cases of mix-ups and displeasure between whole communities. The cultural change which the relocated chinantecs and mazatecs lived is a factor that mention repeatedly in their oral testimonies, gathered by work of field made in the Papaloapan river basin during the year of 2002.

119. May-Britt Öhman, Sweden

Power relations - the history behind the hydropower plant Kidatu in Tanzania

"Electric power is a crucial service to a number of other sectors of the economy. A high rate of expansion of capacity is a necessary prerequisite of economic development. --- The hydro-electric power potential is a major natural resource, the development of which, both in the coming Plan and over the long-term, will form a key task for the economy. ---Taking only those sources for which estimates have been made, it is estimated that electric power potential is as much as 1 325 megawatts. This is more than fifteen times the existing power capacity." The above citation from the Tanzanian Second Five-Year Plan, of 1969, shows an important change in Tanzanian development policy which occurred during the latter part of the 1960s. At the independence, 1961, the most important issue was development by irrigated agriculture. The idea of development

through irrigated agriculture had been promoted by the British colonial government. Sustained by the World Bank just before independence the policy was followed by the Tanzanian independent government and president Nyerere. Hydropower projects were seen as a bi-product of irrigation. Now, with the above cited Second Five-Year Plan, something had happened. Electricity had become important in itself, a "necessary prerequisite of economic development". In the paper I would like to present at the IWHA meeting of December 2003 I intend to describe the history behind this change of view, which at the same time forms a part of the history behind the hydropower plant Kidatu, in the Great Ruaha River. The change implies not only a change in view of how to make use of water but also a change of providers of technology and science.

Up to 1969, all hydropower plants were constructed by British engineers, using British technology. From then on, starting with the construction of the Kidatu hydropower plant in 1970, the first step of the so called Great Ruaha Power Project, the hydropower sector in Tanzania has been dominated by Swedish and Nordic engineers, as well as Swedish and Nordic technology. Sweden entered into the development assistance of Tanzania in the early 1960s. It started out with drinking water projects, but on site Swedish development assistance staff, who were engineers with experience from hydropower construction in Sweden and in other parts of the world, saw an opportunity to enter into the hydropower sector in Tanzania. Plans for hydropower development, coupled with irrigation, was already under way in Tanzania. The market was at the time controlled by the electric company, Tanesco, which at the time was controlled by British interests and also had a British engineering consultant, Balfour, Beatty & Co Ltd. The Swedish development assistance, which had its own engineering consultant company, Sweco, managed to rule out the British competition during the process that led up to the decision to construct Kidatu hydropower plant. The construction of Kidatu can be seen as the first step into the Tanzanian big-dam era, and implied as above indicated the change in view on water resources in this country. Irrigation as part of the hydropower plant construction was reduced to almost none, electricity became the most important output.

The paper I intend to present is a description of the process leading up to the decision to construct Kidatu and analysis of the actors involved, their interests and their view upon the natural resources of Tanzania as well as their notion of "development". The period in focus is 1964-1970. The paper forms a part of my work on a Ph.D. thesis. The paper is based on research in Swedish archives and interviews with Swedish engineers who were involved in the above mentioned process as well as the Tanzanian electric company, Tanesco, archives and interviews with Tanesco engineers and other Tanesco staff during a field research in 2000.

054. R. Parthasarathy, India

Water Market Institutions, Law and Public Policy in India

It is evident in recent years in South Asia, agricultural productivity in the command areas of major irrigation projects have been stagnating, while the productivity trends in areas where groundwater is being used show increases. Though groundwater and surface water were supposed to be used in conjunction, the problem with groundwater, however is, it is temporal and spatial depending on location of the source, structure and institutions. The surface and groundwater use in India have enormously expanded from the 1950s. However, the water markets that have emerged and the intense exploitation of groundwater have led to concerns about the depletion of the resource and its impact on ecology and environment. Further, there are also equity dimensions of groundwater extraction and use. Important is the differences between rural poor and elite in their access to this resource. Though groundwater is a renewable resource, the rate of extraction and the depths at which the aquifers are tapped have led to concerns about sustainable extraction rate.

The history of water use at macro level shows that government has promoted their use with subsidies in the initial stages. However, recently, with better understanding of the characteristics especially of groundwater - the problem related to resource depletion and social discrimination - the governments are looking out for newer policies for extraction and use planning. For some time though, pricing was considered to be the best policy mechanism to govern water use. This route conflicted with the property rights regime under which the owner of the land enjoys unfettered rights to extract water underground and with governance aspects of surface water. This research paper will focus on these issues.

The study would contribute to the national water policy that is emerging in the countries of South Asia, especially in the various states of India. Policy tools like water pricing; electricity tariff and subsidy will be studied in terms of their relevance in solving groundwater problem and promoting conjunctive use with surface water. It is also expected to provide a rich understanding on the functioning of water markets and the institution-policy interface.

116. João Pato, Portugal

The Value of Water as a Public Good in Portugal

Water public policies in Portugal have had a continuous and somehow linear evolution since the eighteenth century until late twentieth century. However, since Portugal was fully integrated as a member of the European Community, its political, environmental and economic matrix, in what concerns water valuation and management, has changed enormously.

This paper will try to contribute with three different objectives in what concerns the history and value of water: an historical perspective on how water has been treated as a public good in Portugal; the development of a conceptual framework that shall contribute to a comprehensive analysis on the value of water at present times, from a political perspective; a critical analysis on the procedures of evaluation of water as a public good in Portugal.

The first objective - an historical perspective concerning water as a public good in Portugal - will concentrate on water public policies in Portugal, from three different perspectives: (i) - a normative level, concerning water laws and water legislation procedures; (ii) - an institutional level, concerning all types of institutions involved with the management of water resources from a public perspective; (iii) - a socio-cultural perspective, mainly concerned with the dialogue that these types of institutions have built up with regional governments and populations in different contexts (searching for contrasts).

The second objective - to build a conceptual framework for the comprehensive analysis of the value of water from a political perspective - is centred in a basic presumption:

The success of a public policy depends on the capacity to implement a set of diverse social values through a clear line of action. This line of action is dependent on the communication ability between a normative / institutional background and a politically integrated population.

In order to evaluate and analyse this relationship, I propose three major dimensions:

i. Cognitive / Scientific dimension: public policy requires a cognitive contribute from the scientific field in order to accomplish better (more rational and efficient) results in what concerns institutional and political action. This dimension identifies the major scientific areas where knowledge can be produced and / or applied to the public policy scenario.

ii. Communicative / Relational dimension: if we understand public policies as a process where consensus and the orientation of social action are the major guidelines for a governance purpose, then it turns obvious that there is a communicative and ethical rationality that as to be understood and developed. Values must be communicated and well understood if we wish to implement them as action guidelines.

iii. Formal / Institutional dimension: how to connect objectives and forms of implementation? How to go from ideas to practices? this third dimension focuses on the necessity to build normative regulations and institutional environments that allow to implement new forms of social cooperation and innovation.

The three dimensions are interdependent and interconnected at every stage of analysis: we can't separate the conception of values without reasoning the ways to promote a communicative context where values are discussed and attributed; there's no way we can promote new values without a normative / institutional framework; science can play a fundamental role in the understanding of this processes as well as in with the identification of new forms of action.

The third objective of this paper - critical analysis on the procedures of evaluation of water as a public good in Portugal - will be to apply this model to the contemporary situation in Portugal and help make visible the major critical situations.

The three objectives aim at helping understand the processes through which societies value water in contemporary times

156. David Pietz, USA

Floods, Drought, and Pollution: The Huai River during the People's Republic of China, 1949-1999

This paper will explore the changing context of Huai River management during the People's Republic of China (1949-). More specifically, the paper will explore such themes as: centralization vs. decentralization (of water management), mass mobilization, labor-intensive vs. capital intensive investment priorities, and economic development vs. environmental protection, and self-reliance vs. international technical and financial cooperation. In general the paper represents a broad overview of the changing context of China's water management (or resource management) spanning the Mao and post-Mao period. The critical question is how has China's water management, as reflected by Huai River conservancy programs, evolved over the past fifty years, and what have been the outcomes of these different approaches, and how the the different development paradigms that these approaches have been embedded in have fundamentally altered the landscape (both human and environmental) of the Huai River valley.

170. A. Rajagopal, India

Dynamics of Water Institutions and Livelihoods of Poor in a South Indian Canal Irrigation System over a period

The paper is about the water insecurity situation in an irrigation system, factors contributing to the scarcity condition, the role of institutions in reducing water insecurity and improving the livelihoods of poor. The paper also analyses the dynamics of these institutions over a period and their impact on farmers' livelihood. These observations are based on a study of a canal irrigation system in South India in 1980s and a resurvey of it after a period of 15 years.

The study rests on the premise that irrigation institutions and their role in management are significantly conditioned by the agricultural and socio-economic environment especially caste and class of the region. Maintenance of irrigation structures and regulation of water supply to tanks under large-scale irrigation system is fully the responsibility of the State. However the State is not able to undertake these functions efficiently due to its own constraints. Hence local level irrigation organisations undertake maintenance like cleaning and de silting of channels, which bring water to their tanks. Though the State is not able to regulate water to the tanks properly, local institutions themselves undertake such tasks. Collective action both in the appropriation of water from the main canal and allocation of water at the local / tank level is quite significant. These organizations called panchayat have well defined structures, rules and functionaries. The members of the panchayat are generally farmers with relatively larger land holdings and community influence in the village. They are assisted by professional watermen and watchmen, appointed during every irrigation season and paid through the farmers' contribution. Thus collective action as regards functions of water management is quite significant and brought substantial benefits to farmers including small farmers in terms of access to water and productivity gains from irrigation. Had there not been such institutional arrangements there would have been substantial losses to farmers (especially small farmers) because of overall reduction in the quantum of water in the system due to the inter-state river water dispute and the increased problems due to encroachment and alkalinity of soils.

Though there has been a significant change in the land control, the villagers continue to show interest in collective action as majority of their livelihood depends upon agriculture for which irrigation is the basis. Not only irrigation but also the very life of villagers depends upon cooperation among themselves for the fear of subordination by the dominant castes. The continued

presence of irrigation institutions and their role in water management and other village affairs point to the fact that pessimism expressed on collective action by theorists of 'tragedy of commons' like Hardin, and Gordon is exaggerated.

The resurvey shows that irrigation systems do not exist as blue prints but continue to undergo changes in which institutions are important. Though there are many changes in irrigation and agriculture, caste as an institution continues to play an important role in irrigation and other village affairs.

178. Jorge Rodrigues, Spain/Belgium

1000 Years of Irrigation Law: the Development of a Sustainable Model in the Hydraulic System of the Segura River (South East Spain, Xth-XXth c.)

The irrigation system created around the city of Murcia, based on the control of the Segura River in South East Spain, is the result of a complex historical development. This development includes a unique group of rules that adapted peasants' customs and crystallized into a series of written Codes whose trajectory can be followed from the XIVth century till nowadays.

The creation of the Segura's capital city, Murcia, in 825 was the result of the will both of the central State to constitute a political and administrative centre for the lower basin, and of the inhabitants to assure its prosperity through an extended irrigated area. As a matter of fact, the existence of the City depends on the strict management of the river's water (for the area is one of the driest zones in Spain) and the effective defence against the periodical floods of the main river and the Guadalentín, a particularly dangerous tributary when adding its caudal to the Segura during the raining season.

The history of the irrigation system has been focused, on the one hand, on the design and implementation of strategies to avoid and/or to diminish the risk of catastrophic floods and on the other, the expansion of irrigation. The City and a number of powerful citizens and institutions with the ability to influence municipal decisions obtained new irrigated lands from draining marshlands. The extension of a complex drainage system preceded the installation of the irrigation network, and the drainage canals were connected to the general defence system against floods. This expansion process accelerated during the XVIth century and reached its maximum intensity in the XVIIIth century. During the XIX century, a combination of State intervention and empowerment of communities resulted in an almost absolute control of the river, the end of the marshlands – including the endemic diseases associated with them, e.g. malaria, and the exploitation of all water resources for an irrigated/drained area that has reached its limits nowadays.

This paper assesses the model chosen to control effectively the river -a source of economic wealth and a permanent danger due to violent floods and diseases derived from the lack of appropriate drainage. This model is based on the assumption that cooperation among the irrigators is essential for the effective management of the hydraulic system, but also that a certain coercive element – coming from the irrigators themselves, the basis of the irrigation law, is necessary for the survival of the system. This is a model different from the classical Wittfogelian despotic structures of management, and also from the private organisations proposed as the solution for the "tragedy of the commons". Traditional principles coming from original customs and refined through different socio-economic and political frameworks have proven to create ideally a sustainable model of water management and an efficient strategy to solve conflicts between the components of the system.

Francisco Jorge Rodríguez is a researcher at the European Common Law Institute in Murcia, Spain. He is a PhD candidate in History of Law, and his areas of interest are related to the development of State, municipal and community responses to effectively manage water as a common resource and to solve conflict situations. He is interested on the aspects of History of Law, Socio-Economic History, Cultural History and the mechanisms of conflict applied to water-related issues. He is working as a Consultant for EU-funded projects related to research, Mediterranean and Enlargement issues in Brussels, Belgium.

077. Thierry Ruf, France

The King Martin' Chart in 1400

An precocious example of water conflict resolution in the Pyrenées-Orientales, France

The chart of the King Martin was written in 1400 in the city of Perpignan. In few dense pages, the text show a very early way to reform the irrigated system established in the year 1337 for the city of Perpignan and for the irrigators of a village named Thuir located at 10 kilometers. The canal was built with a agreement between the main City, centre of the Kingdom power, and the inhabitants of the village. 63 years after this, the people of the village ask for a important reform because of a lot of difficulties in water management and prejudicial consequences on all the economy.

The Chart refers first to the agreement of 1337. Analysing the document, we shows that many aspects were précised in the rules. The initiative of the canal is public, linked to the kingdom administration. In terms of flow, the engagement of the state is fixed (a flow to move six water-mills. The definition of who may use the available water for agriculture is very clear : only the members of the community of Thuir. As the canal is a public canal, all the maintenance has to be charged to the State. But every recognised user pays a cota for each plot that he may irrigate, even if there is no crop on it, each year, except the vineyard. Furthermore, if the inhabitants can't irrigate their plots because of a breaking of the main canal (war, natural disaster, water scarcity,...), the cota will not be paid.

In 1400, the representatives of the village met the kingdom authority in Perpignan because of many troubles on water access in the territory of Thuir. They argue that these difficulties have also a lot of consequences for the city itself. The first problem seems technical. As the Intake of the canal is badly located in the river Têt and many times, is out of function, the representatives suggest the construction of a new intake upstream in a rocky part of the river bed. Of course, they ask the State to pay the investment, at least to finance it.

Going on in the reasons of water scarcity, they ask the authority to publish again the agreement and rules of 1337, and they immediately denounce the formers acts of the kingdom authority which gives to many new users water rights outside the original territory defined in 1337. They proclaim that the corruption was going on many years and it is the reason of water troubles not only for the inhabitants who cultivate but for the inhabitants of perpignan itself. So they ask an inventory of all the titles of water access and demand to go back to the first rules, with the revocation of the non legal concessions. They require the respect off all the operating rules and through these conditions, they accept to participate to the investment of the new intakes according to their advantages.

In matter of fact, Catalan people are inventing here what should be well known in the Xxth century, the principles of the common property regime (see Ostrom, 1992).

081. S. Salequzzaman, Bangladesh

Sanitation and Portable Water History in Bangladesh, and Recent Perspectives for Their Sustainable Management

Historically, Bangladesh had been suffering seriously from lack of poor sanitation and portable water supply until 1980s. Because during that time, Bangladesh's population density and lack of access to adequate sanitation had led to severe microbiological contamination of surface water, resulting in high levels of morbidity and mortality. Until the 1970s, most villagers used to drink from hand-dug wells, ponds, canals or rivers, and often shared water from the same source with animals. People in those days used to drink such highly polluted and bacteria-contaminated surface water that exposing themselves to the endemic and deadly diseases like diarrhea, dysentery and other intestinal ailments. Those water-borne diseases used to take a huge toll of lives every year, but no one noticed any symptoms of arsenic poisoning.

However during the last two decades, it is assumed that Bangladesh has been achieved a remarkable success to manage on these portable water supply and sanitation practices, particularly in the area of sanitation. But recently discovered ground water arsenic pollution has stunted to

these successful trends. Many peoples has been affected by drinking of this polluted ground water that finally turned into a serious environmental health issue of the poor peoples of rural Bangladesh. Still, the success of sanitation practices have been continuing, because of a strong motivation and awareness program has been conducting by different organizations since 1970s, in particular many non-government organizations. The same activities have also continuing to the case of remediation process of ground water arsenic pollution. But the problem is, the remediation activities have been conducting at the same place by many organizations without coordination among them, and give the different formula to solve the same problem and same health effects.

Thus, community poor peoples are confusing to take their decision- on which problem-solving formula is better. Because a lot of recommendations have been suggested from many local, national and international organizations including the government itself. Ironically, community peoples needs a very simple formula or process by which they can take their affordable drinking water from ground water or surface water or rainwater sources. In this situation, the paper will discuss elaborately on barriers of community poor peoples to take-up the already innovated technological solutions of arsenic pollution, and the factors responsible for the successfulness of sanitation practices in rural Bangladesh. Finally, the paper will discuss an innovative participatory community-based model for the sustainable management of portable water supply in the ground water arsenic polluted areas of Bangladesh. In both cases, the paper will try to relate the historical perspectives of the problems and sustainable solutions.

090. Christian Schleyer, Germany

Economic and Ecological Transformation Processes in Post Socialist Water Management Regimes - A Case Study in Brandenburg (Germany)

Abrupt changes in a nation's political and economic structure - like the reunification of the two German States - very often have long-lastingly destabilising or even destructive impacts on existing management systems for local natural resources like water. Such all-encompassing societal changes might result in completely altered resource use patterns, new actor constellations of resource users, reallocation of property and use rights on the resource or on the related management infrastructure as well as in decisive changes at all levels of administration. In order to 'design' future concepts for a (renewed) sustainable natural resource use one has to develop a deeper understanding of these transformation processes and their historical determinants.

Taking an economic historian perspective, this paper will focus on economic and ecological transformation processes in post socialist water management regimes illustrating the case of the low moor region 'Schraden' in the East German state 'Brandenburg'. Here, a long-standing intensive arable farming - enabled by complex melioration - has caused soil deterioration and high water runoff. More than ten years of economic and political transformation has worsened the situation and even added new problems. The visible consequences are drought periods in the summer, waterlogged plots in the spring and worn-down water management facilities that operate in an uncoordinated or even unauthorised way.

It is here argued that the reallocation of property rights on melioration systems, together with ineffective co-ordination mechanisms, have impeded appropriate land use. Transformation-related problems like the discontinuity of land property rights, the unclear legal situation regarding melioration plants built in socialist times, and highly-fragmented land ownership have not been effectively dealt with by the newly-established Water Association and Water Administration, respectively. Profoundly heterogeneous water-user interests and the complexity of ecosystem relations have contributed to the persistence of the problems.

Furthermore, the article will also provide a comprehensive overview of the history of water use and water management in the region before 1990. Among other things, it will be highlighted that many issues raised after the reunification can only be understood by exploring the earlier history of water and land use in the Schraden.

This analysis is based on archive material, contemporary documents and regional planning material as well as on qualitative, semi-structured interviews with local stakeholders, representatives of the administration and politicians at all levels of government.

159. Pradeep Shrivastava, India

Multiple Stakeholders, Rights, Benefits and Responsibilities in Water Use

A typical urban lake in a developing country faces many problems with respect to allocation of rights of water use and responsibilities of its ecological management, among its various stakeholders. Perhaps the objective of the origin of these water bodies, with the passage of time with development taking place, shifts or some times expands. As a result composition of its stakeholders also changes, which in turn questioned the sharing of its benefits and responsibility of management for its sustenance and regulating the uses, allocation of water rights and ownership.

As with many resources, when water is abundant there is relatively little attention given to rights to use it. But with increasing scarcity and competition for this vital resource, there has been a growing attention to water rights in recent years. Unfortunately attention has been paid to only formalized statutory rights. Water rights have to be seen not only from the formal statutory view point but other basis of claiming water should also be considered. Formal laws are important but they fail to coincide with peoples own perception of water rights. Recommendation made exclusively on one type of regulating law may not adequately address the problem of resource allotment and responsibility of their management. The policies and legal changes, change the rights radically from locally accepted notions. The water availability and demand fluctuate from year to year. Stronger water rights still work even during scarcity periods, weaker rights may be declined.

In the present case study users and managers have been found to be two different classes inhabiting catchments and area out side catchments of the water body. Individual users often occupying area out side the catchments receives multiple benefits without responsibility of management for its sustenance. Whereas the other class called managers, without any right to water or deriving benefits from it, has to, at individual level bear the burden of its ecological sustenance.

Certain users ceased to have their rights of access to water in due course of development/urbanization of the area even their physical closeness to the resource has not been of any help in continuation their rights to the water. It has also required them to change their livelihood pattern or some times totally abandon the traditional profession, farming in most cases. Statutory rights (drinking & irrigation) have adversely affected the other users (fisheries, religious, aquaculture practice, recreation etc) in the present case during scarcity period.

046. Suman Sijapati, Nepal

Evolution of Irrigation Technology and Institutions in Manusmara River Basin

Up to the mid 1960s, large portion of Manusmara Basin, a river basin in the Terai of Nepal, was covered by dense, Sal forest. However, with the inflow of people during the 1950s and 60s, the forest was converted to agricultural land and presently only 6% of the area remains occupied by forest. The basin is covered by rural settlement with more than eighty percent of the population involved in agriculture. Consumption of water especially for agriculture has increased tremendously. This paper, based on the finding of the "Water Accounting and Water Institutions' Study of Manusmara River Basin" carried out by the Department of Irrigation, draws out the history of agricultural development in the basin and its interface with the efforts made by the farmers to use the available water resources in the basin.

The paper illustrates how irrigation technology adopted by the farmers changes with changing scenario of water requirements and availability. The evolution process has been traced from the estimated origin of human existence in the basin more than 200 years ago when the people of the Yadav community, with their livelihood based on cow herding, dominated the locality and mainly practiced subsistence farming with shifting cultivation of rainfed crops. The paper describes the

changes brought by the introduced of rice and its gradual expansion in the area. It also explains how inundation canals (kulos), which were originally sufficient, later had to be supplemented by temporary earthen dams at appropriate locations of the river. Paper also explains how the immigrant boom to the area increased pressure on the land resources in the basin and consequently lead to intensification and diversification of cropping system. This crop diversification augmented by the introduction of higher yielding varieties requiring stricter water management resulted in the need to have more control over water. The paper then goes on to explain how modern diversion structures with regulating steel gates were introduced and expanded along the river.

The paper also explains how the water use institutions have evolved in the basin and how their roles have changed through time. In the olden times the main challenge for farmers was to mobilize resources for the acquisition and allocation of water. The labor requirement was high but the social structure and norms were instrumental for such resource mobilization thus those activities were carried out through temporary, informal organizations. However with the intensification of agriculture and the consequent need to have more control over water not only were physical structures needed but also more formal organizations were felt necessary. The paper then goes on to explain how Water Users' Associations (WUAs) came into existence in the basin and how their role has changed and is changing with time.

Kulos are indigenous irrigation systems constructed by the local farmers. They simply consist of an inundation earthen canal network dug from an appropriate location in the river. During the monsoon, the water level in the river rises and the water flows through these canals to irrigate the paddy fields. There is no mechanism to regulate the flow.

Temporary earthen dams were constructed with objective of addressing the critical requirements of rice during land preparation stage. Each year these dams would be constructed before the monsoon, sometimes during the month of May. They would only survive until a major flood would destroy them. Thus dam construction was a continuous process. This tradition of earthen dam construction was very prevalent up until two decades ago

062. Chamhuri Siwar, Malaysia

Development and Marginalization: Case of Aborigines in Langat River Basin, Malaysia

This paper discusses the relationship between development, marginalization, poverty and environment amongst the aborigines or Orang Asli of the Langat River Basin. The Langat River Basin has developed and transformed tremendously, from being an agricultural area to an industrialized and urbanized area, providing vast employment and business opportunities and affecting population and employment structures and migration patterns. However, the aborigines are still among the poorest communities, bringing the notion that they have not effectively benefited from the development around them. Marginalized communities are generally defined as those being marginalized or squeezed by development all around them. This raises the question on the sustainability of development in the Langat River Basin. The framework for the analysis links between the concepts of sustainable development, poverty, environmental and natural resources conditions, which brings into focus the interplay between development, poverty, and natural resource degradation. Environmental conditions such as access to and ownership of natural resources (land, water), ecosystem services (forests, grassland, freshwater, agro and coastal ecosystems), access to safe water and sanitation, pollutants, ecological fragility and likelihood of natural disasters affect various dimensions of poverty such as livelihoods, health and vulnerability.

Access to and ownership of natural resources and ecosystem services affect the ability of the poor to sustain their livelihood. Limited access to and insecurity of ownership to land and natural resources also affect income levels. The landless Orang Asli acquire inadequate income and hence subsist under poverty conditions. Ecosystem services or functions from forests, agriculture, fisheries, etc while providing valuable sources of income to the Orang Asli, ecological vulnerability and low levels of biological and resource productivity also affect their livelihood. Hence, sustainable management of these natural resources and ecosystems is important to sustain their livelihood. Environmental health also affects the ability of the poor to move out of poverty. The health status of communities may be affected by environmental conditions such as access to safe water and sanitation and also the presence of pollutants in the air and water. The burden of diseases among

the poor may also be influenced by environmental factors such as lack of access to clean water, inadequate sanitation and poor hygiene practices. The vulnerability of the poor may be increased due to ecological fragility and exposure to natural disasters like floods, landslides, drought, forest fires, etc. Resource mismanagement or overexploitation may lead to environmental degradation, which may contribute to fragility and exposure to natural disasters. Vulnerability leads to insecurity, risks to exposure to environmental hazards, susceptibility to loss, incapacity to recover and weak coping position. The poor are most vulnerable to environmental stresses and shocks, both in the short and long run.

Environmental conditions clearly affect the various dimensions of poverty. The livelihood of the poor, tend to depend more on natural resources and their environment services. Hence, lack of access, insecurity of ownership of natural resources and degradation of the environment would severely affect the poor. Lack of access to safe water, inadequate sanitation and pollutants from biomass fuels, agrochemicals and waste dumps will affect severely the health status of the poor. The poor will also be more vulnerable to natural disasters and ecologically fragile conditions, causing insecurity, exposure to risks, susceptible to losses, incapacity and weak coping mechanism. This paper discusses the relationship between development, poverty and marginalization among the Orang Asli in the Langat River Basin in Malaysia, and assess implications for poverty alleviation and sustainable development in the river basin.

163. Dragica Stojiljkovic, Yugoslavia

Contribution to History of Legislation Regarding Groundwater Protection

In Serbia, 19th century is known as period when health food, noise, high-quality drinking water, soil and air protection, but also environmental protection, were very important. After Turks reign, new country made legislation for the first time in 1850. Of 40 paragraphs in the legislation, five are related to water protection. As these paragraphs were made 150 years ago, they can be defined as "hystorical" ones. It is interesting to note that all of them analyze individual infractions, which means that production activities in Serbia were not of so significant volume of production, hence, water objects and environment were not disturbed by them.

At the territory of today's Vojvodina, within Austria-Hungarian legislation, the first law in domain of water protection, regulating flood protection, was made in 1807. Under available water, all spring, atmospheric and ground waters present at the private property were considered. Owner was permitted to use and to perform appropriate work. Under controlled water, it was possible to use water as public property - for sailing, rafting, washing, watering, bathing, water power consumption and water supply. For other purposes, licenses and rental agreement for some period were issued. Use of water for irrigation was not regulated as other purposes, because, at that time, flood protection, surface water management, soil draining and individual water supply were of primary importance.

During governmental authority of Obrenovic family, Law on Water was made in 1878, where surface water management in state and private property was regulated in similar way.

Analysis of rules regarding environmental protection in today's Yugoslavia shows that this topic is regulated by numerous rules of different level and character. Some of them are directed to problems of environmental protection and some media of the environment, while some have certain influence on strictly defined questions of the protection of the environment. Exploration, exploitation, management and protection of water is regulated by the following legislation acts: Law on basic geological activity of interest for the country, Law on geological exploration, Law on Mining, Law on aquifer consumption and protection for water supply, Law on environmental protection, Law on spas, Law on waters, etc.

168. Erik Swyngedouw, UK

Flows of Power : The Political Ecology of Water and Urbanisation. The Case of Guayaquil, Ecuador

This paper contributes to the formulation of a political-ecological perspective on the process of urbanisation. The objective is to excavate the political-ecological power relations through whom

water becomes urbanised and, subsequently, how the control over and access to water has become socially highly stratified. In the case of Guayaquil, Ecuador, for example, 35% of the more than 2,000,000 inhabitants have no access to piped potable water. This paper seeks to document and analyse the power of water in the context of Guayaquil's urbanization process and to suggest strategies for an emancipatory and non-exclusive production, conduction, and distribution of urban water.

The paper analyses the political-ecological dynamics through which the contemporary urban waterscape and hydrosocial cycle in Guayaquil became constituted. We shall undertake the archaeology of the urban water networks, and reconstruct how Guayaquil's 20th century history became etched into the technical, social, and ecological structures of the water system. This history and current geography of the city will be written from the perspective of the necessity to control and harness water flow into and around the city. The socio-economic and political-geographic power relationships determining access to or exclusion from water will be analysed in the context of Guayaquil's urbanization process. In addition, I shall explore how these practices vindicate social and economic power relationships at the local, national and international scales. Attention will be paid to the 'Water Mandarins', which organize and control the production, conduction and distribution of urban water in Guayaquil, will be charted with a focus on their internal and external relations. This will include an analysis of the relationship between external funding agencies (the World Bank and others), national government, and the local and recently privatised water company. In addition, infrastructure and investment planning, price mechanisms, and control structures will be explored in the light of the disempowering mechanisms of the existing water system.

In the final section, the struggles for water power will be excavated.. These struggles exemplify the dynamics of the Guayaquileño urban political-economy and highlight the mechanisms of domination-subordination and participation-exclusion in the context of peripheral urbanization processes. Attention will also be paid to 'people's power', to the weapons deployed by the weak, and the ingenuous mechanisms mobilised by individuals and social groups alike to secure access to at least some of the available water. The section will conclude with a discussion of the struggles over access to water in the practices of everyday urban life. We shall conclude by considering strategic issues related to the possibilities for an emancipatory and empowering development.

085. Mattias Tagseth, Norway

On the Development of Hill Furrows. Methods and Examples from Kilimanjaro, Tanzania.

The paper discusses methods to approach events and processes in canal construction prior to or sparsely documented by written history. Kilimanjaro in Tanzania remains the largest centre of indigenous hill furrows in East Africa. Historical sources show that a considerable infrastructure was developed before the 20th century, supporting relatively dense population concentrations. The development of the local irrigation traditions is central to the history of settlement and livelihood the region.

The question of the antiquity of the irrigation technology in Kilimanjaro was raised by Masao (1974), who attempted to use naming, some oral tradition and oral political history prepared by Stahl (1964). We may wish to take advice from oral history, claiming that mfongo irrigation has been practiced since 'time immemorial', leave beginnings aside and move on to the study of irrigation development. In any case, there is a need for methods and sources. Masao's sources did not permit him to move beyond political centralisation in time, and he accepted a claim that Chagga settlement was only 3-400 years old, based on the settlement history of one chiefly clan. Oral traditions claim that irrigation preceded political centralisation, and canals are mentioned in connection with events in the 17th century. Strong links between princely rule and irrigation have been assumed, but are not obvious for any of the old irrigation districts in the region (cfr. Kimambo 1986, Feierman 1990).

Suggestions have also been developed in studies on the Rift Valley cluster of hill furrows. Soper (1983) attempted to correlate scheme establishment in Marakwet with the age-sets, which were mobilised during initial construction, but his informants failed to provide sufficient data. Association with settlement has been used for indirect dating. Soper also suggested dating from radiocarbon dating of trees sustained by seepage, but validity remains an issue with indirect methods. The

stratigraphy of a furrow network could yield a sequence, the main problem being frequent reconstruction of canals of this type. More promising suggestions appear to rely on a correlation between scheme establishment and the institutions of irrigation management, as attempted by Masao with chieftaincy, Soper with age sets and Tagseth (2000) with furrow- controlling patrilineages. This method is illustrated through the analysis of furrow establishment in upland Marangu. It relies on the institutions in water management, and on a close relationship between people and their ancestral land, which prevails in highland areas in the catchment of the Pangani River. Hereditary furrow elders and their family groups keep track of their relationship to canal founders as a basis for management rights. It is thus possible to get location-specific data on past actors and events in resource management. Genealogies and detailed family and scheme histories could be put together confirm that specific furrows were established in the first half of the 19th century, and shows how new canals were constructed with the growth of the settlement. The example shows that location- and family-specific oral history can be used to reconstruct changes in resource use over long time periods, and it documents one phase of the expansion of the system.

150. Elise Tempelhoff & Johann Tempelhoff, South Africa

The community, industry and the quest for a clean Vaal River 1997-2003

Since the 1920's the Vaal River on the southern border of the Gauteng Province in South Africa has played an important role in providing the country's economic heartland, with water. The quality of the river's water however deteriorated in the 1930s as a result of an increasing inflow of sewage and industrial effluent.

The result was that the central government, along with Rand Water, the largest water utility in South Africa, over the years made innovative plans to provide the region with water. In what is generally considered to be a country with limited water reserves this was a major accomplishment.

Since 1997, with the introduction of South Africa's new water legislation, a community of small farmers close to the Vaal River and in the vicinity of a large steel factory, took the steel giant to court for polluting the underground water supplies. The process of democratisation, which started with the country's first multi-racial elections in 1994, had empowered ordinary people. It also brought a new type of responsibility for the government - securing co-existence for all sectors of society.

In some respects what is at issue is a sense of empowerment as ordinary people stand up for their rights to clean water and compensation for damage suffered over many years. More important is the task of government to contemplate responsible decision making in the process of conserving South Africa's scarce water supplies.

In the paper an attempt is made at addressing the problem of water pollution from the perspective of a community directly affected. There is also an exposition of how the authorities have attempted to find solutions to a problem that requires decision-making that must take cognisance of the principles of economic development and responsible environmental governance.

149. Johann W.N. Tempelhoff, South Africa

Rand Water and the Transition to a Multiracial Democratic South Africa 1989-1994

South Africa's transition to a multiracial democracy in 1994 has been hailed as one of the political wonders of the twentieth century. The major accomplishment was the fact that the change to majority rule did not coincide with violent political turmoil. Much of the success for the transition can be ascribed to the fact that important role players took the necessary steps to secure a smooth transition. Rand Water, South Africa's largest water utility, was one such organisation.

In the paper attention is given to the pro-active manner in which the management approached the transition from the outset. The style of management changed and water utility re-invented itself by undergoing a change of public face.

Amid all the change and restructuring of the political and administrative landscape plans for a new water supply scheme were introduced to increase the 1991-consumption figures of 2328 ML/d up. Rand Water had to cope with an anticipated demand of 4872 ML/d by 2010. Rand Water also started changing its role from bulk water supplier of large local authorities, to that of supplying water to small local authorities and areas historically disadvantaged communities.

Finally attention is given to the participation of Rand Water's management in negotiations with the political role players leading up to the change of government in May 1994. Ultimately the commitment of the water utility to provide a first class service played a small but important role in the transition to a new dispensation in South Africa.

174. Robert G. Varady, USA

Global Water Initiatives since the International Hydrological Decade (1965-74): Their Evolution and Significance.

The proposed paper is a brief history of institutions known as "global water initiatives." Each of these initiatives has sought to improve society's management of the planet's water resources. The phenomenon reflects a post-World War II trend-in this instance, beginning with the International Hydrological Decade (1965-74)-toward collective approaches to resolving multinational issues in general and common-pool resources in particular. The central question to be addressed is whether the 'world of water' would have been much different if these initiatives did not exist? The paper is part of a project that aims to formulate a critical history, synthesis, and assessment of the global-water-initiative phenomenon since the early 1960s.

Global water initiatives have proliferated because of the general belief within the water-development community that water transcends national boundaries and must be managed cooperatively, equitably, and with reference to the best science. The paper will offer a preliminary evaluation of the effectiveness of these initiatives, which arguably have become the dominant model for international water-resources management. Based on lessons from a half-century's experiences, the results should interest scientists, social scientists, diplomats, and managers, and especially decisionmakers at all levels, who "need to ask questions about history and to reflect on the past before they can address contemporary challenges" (Martin Reuss, in "Historical perspectives on global water challenges," Water Policy 2000).

Over the past two decades, numerous environmental historians have studied aspects of water in different societies. The proposed paper looks beyond individual regions or topics and instead analyzes a metaprocess: the rise of institutions with genuine expectations of influencing water management on a global scale. The paper will be based on field research and preliminary analysis to be accomplished in the course of a sabbatical by the author in Paris, France, beginning in September 2003.

112. Espen Viddal, Norway

"Equitable utilization" as a legal norm in international law.

This paper will explore the nature of the term "equitable utilization" as an international legal norm in relation to international drainage basins. It will be shown that while not being substantive international law as such, the inherent dynamic properties of this norm make it applicable to virtually any international water dispute. Unlike other legal norms it demands flexibility and negotiation in order to determine the precise mechanisms to be invoked. As such, one might say that the norm is more within the realm of diplomacy than that of law. The research shows that a specific legal regime thus should be determined through an analysis of the temporal socio-economic asymmetries between the co-basin states. However, this demands that the legal regime in itself also must incorporate dynamic properties. A relative socio-economic advancement of one basin state might lead to it being imposed greater restrictions within such a regime.

The research has also indicated that formerly discarded doctrines regarding the law of international drainage basins might very well be in the need of revival. Through a deconstructive analysis of the historical evolution of the legal norm "equitable utilization", the paper argues that even though the

norm is dynamic and incorporates flexibility with regard to the precise nature of a regime (depending on the geographical context and timeframe), there is no doubt that a marginal socio-economic state does exist, at which point the norm is static at least for some elements of utilization. The paper also argues that based on the described understanding of "equitable utilization", the rule of "pre-existent appropriation" must be discarded as a universal rule under the law of international drainage basins. The rule of "pre-existent appropriation" has generally been deducted by analogy from similar rules of historical fishing rights. However, such exclusive economic rights in the high seas are not based upon a principle of "equality of rights", as oppose to the case of international drainage basins where this principle is of fundamental significance.

This paper proposes an alternative approach which may give room for the existence of regional (or basin specific) rules of "pre-existent appropriation" based on procedural rules. Since the dynamic understanding of "equitable utilization" implies that there can be no standardized allocation regime, and as such all drainage basin legal regimes will by definition be "regional". The paper proposes a preclusion rule in effect whilst establishing a new legal regime of an international drainage basin, which precludes arguments in opposition to mutually consistent domestic water law in all co-basin states. The negation of this rule will thus be, given that all co-basin states' domestic water law acknowledge rules of "pre-existent appropriation", that such a rule may be valid within a limited geographical context. Such a rule will on the other hand be very sensitive to changes in domestic legal regimes. Existing uses and the importance of these in a basin state economy are however of significant importance when determining what is "equitable". The paper focuses mainly on the Nile River Basin as a case example.

091. Eberhard Weber, Fiji

The Political Economy of Water Supply in Suva, Fiji Islands

Most of the small islands of the Pacific are facing severe water problems. Quite often very small and without meaningful catchment areas they experience increasing demands from expanding populations and tourism; continued over-exploitation and pollution of limited ground-water resources; environmental degradation of coral reefs and vulnerability of the Islands to natural disasters and climate change. Unclear property rights of water, the existence of traditional as well of modern institutions of water allocation and limited resources of governments and municipalities to finance the establishment and maintenance of adequate water supply systems worsen these trends. All these threats and shortcomings have a direct impact on the health, livelihood and well being of the 7.6 million people who live on the more than 10,000 islands of the Pacific.

The paper analyses the situation of water supply in the Pacific Island region. The very heterogeneous nature of the islands (e.g. low lying tiny atoll and limestone islands with insufficient surface water and small groundwater lenses; bigger, high islands of volcanic origin) causes a great number of various problems related to the water supply of rural and to a growing extent urban population. The general discussion of various causes of water scarcity in the Pacific Island region is deepened by a case study on the political economy of water supply in Suva, Fiji Islands.

With a population of less than 100.000 Suva is the biggest city in the Pacific Island region. An annual rainfall of more than 3000mm makes Suva to one of the "wettest" capitals on globe. Despite this abundance of water since many years the administration of Suva is facing severe problems to supply sufficient water to all its inhabitants. Especially many residential areas in the hilly suburbs are facing severe scarcity of water.

The water stored in the four reservoirs is not enough to supply to all parts of the town, and therefore many citizens of Suva have to be satisfied with piped water every second or third day. Some areas don't receive water for months, and in case the inhabitants are lucky they can get supply by the one of the 12 water trucks of the Public Works Department (PWD). Those who are not this lucky have to make their own arrangements to secure their water needs. Especially most of the many squatter settlements in Suva have no sufficient supply of potable water. Outbreaks of water related diseases in these areas are therefore rather frequent.

Already in the 1970s fears were raised that in the near future Suva wouldn't be able to meet the water requirements for its citizen. Demands to invest bigger amounts of money in order to modernize the municipal water supply system were many. In recent decades Suva and the

Government of Fiji therefore received considerable finance from the Asian Development Bank and the World Bank, which in many cases were not used to improve Suva's water supply system.

048. Mohammed-Bello Yunusa, Nigeria

An Analysis of Socio-Economic and Spatial Factors and Strategies in Urban Water Supply in Some Communities in Nigeria

Access to safe water has spatial variations shaped by socio-economic and spatial factors. For instance, in Africa, 60% of those that have access to safe water in 1995 live in urban areas and the remaining 40% live in rural areas. Yet, as at 1995, a greater proportion of North Africans, over 50% had access to safe water as against less than 20% West Africans (African Development Bank, 1999:118-120). The point is that different people at different places have different access to potable water supply.

Access to safe water has been on the marginal increase in Nigeria since 1990. This can be illustrated from the African Development Bank's selected statistics on Africa in 2002. In 1990, 47% of the population had access to safe water with 75% of this living in urban areas. In 1995, this rose to 49.9% of which 79.5% are urban inhabitants. By 2000, 57% had access to safe water with 84% of this as urban residents (African Development Bank, 2002:206-207). This notwithstanding, the distribution and access to water in towns and cities have varying socio-economic and spatial base. Onibokun (1989:84) has noted the abundance of water resources in Nigeria with variations across ecological zones. This variation and the fact that each state government has a water agency notwithstanding, households in urban and rural areas combine many sources of water supply to meet domestic needs. For instance, in Kaduna, Enugu and Ibadan two-thirds of the households were found to have water in their houses while the remaining one-third are dependent on public stand taps, wells, streams and ponds (Onibokun, 1989:84). To guarantee a greater access, the Nigerian Federal Government sets out to work with State and Local Government Councils to ensure adequate supply and distribution of potable water by tapping available water resources (Federal Government Of Nigeria, 1997:46-47). How far has the government been able to pursue this urban water policy? Has the local circumstances of various communities shaped the provision and distribution of water across Nigeria? What local factors impinge on or enhance water provision and distribution in the various communities?

Answering these questions is pertinent to understanding the dynamics of water provision and distribution in Nigeria and possibly the developing countries in general. This paper brings together points of convergence and divergence in socio-economic and political milieu of water provisioning, distribution and access in some Nigerian communities relying on data generated from eight different communities. The task of this paper therefore is the identification of local socio-economic factors that condition water provisioning, distribution and access. In other words, the paper examines how is water provision is organised in the selected communities. It further examines the relationship between individuals, communities and the government in water provisioning given that the way people are governed has implications for planning, environmental issues, transport and social services available to the people (Goodwin, 1999: 194).

The paper utilises some selected literature to establish perspectives on the theory, politics and strategies of urban utilities provisioning with specific reference to developing countries particularly Nigeria. The paper concludes that water provisioning can be more effective to the generality of the people if it is organised within the capacity of the communities taking into account socio-economic and spatial variations. Given the rate of population growth and urban expansion it is imperative for governments to work out models of citizen participation in urban utility provisioning that suits its environment.

118. Dorothy Zeisler-Vralsted, USA

Engineering Rivers: A Comparative Study of the Hydrological Developments of the Mississippi and Volga Rivers

Throughout the past century, the Mississippi River has been dammed, rerouted, and levied for several purposes, including navigation, hydropower, and flood control. The end result of these engineering feats is a hydrological regime; a product of the modern industrial era. One of the consequences of a hydrological regime, however, is a change in how humans perceive and interact with this natural resource. One of the preeminent historians of environmental history in the United States, Richard White, explored this consequence in his research on the Columbia River. His findings were published in *The Organic Machine: The Remaking of the Columbia River* (1995). In this work, White examines the historical relationships that people have had with the Columbia River. He begins with the premise that we are all a part of nature, not separate from it and supports his claim with earlier histories of human interaction with the environment. By looking at the history of the river in the 1800s, White sees a "common denominator" between humans and the river-work and energy. For example in the nineteenth century when the Columbia River was being explored and later traveled, the people who came into contact with the river, measured it in terms of the damage their ships sustained and the amount of labor required moving upstream. Thus human energy and labor linked them with the resource. Today these relationships have been altered and in White's words, we have "obscured a knowledge of the natural world and our place in it-namely that labor rather than "conquering" nature involves human beings with the world so thoroughly that they can never be disentangled."

My presentation proposes to continue along White's path and chronicle the transitions of the Mississippi and Volga Rivers. Comparisons between the two are inevitable as both rivers serve as their country's major artery for transporting goods and sources of hydropower. Because of their size and economic value, the rivers also occupy an important place in their national culture. Mark Twain immortalized the Mississippi River for an American audience and the river towns lining the riverfront all possess a history shaped by the river's presence.

In comparison, the Volga Rivers also occupies a significant place in Russian history. The Russian landscape artist, Isaak Levitan, captured the beauty of the river with his landscape paintings while contemporary photographers in Russia, such as Paul Kolesov, continue to celebrate its beauty. Furthermore, both rivers share a past that included major engineering projects, whether for the purpose of navigation (both are important inland transportation routes) or power. Yet, many of the similar engineering schemes were undertaken when the countries were governed by radically opposed political ideologies. Thus, the role of culture will be examined and how it shaped the hydrological development of both rivers. And when looking at the role of culture and how it shapes resource use, I will discuss what aspects of culture play the largest role-political ideologies or industrialization and modernization. For in the case of the Volga and Mississippi Rivers, their histories of development in the first half of the twentieth century were very similar despite opposing political regimes.

Just as Stalin's engineers planned major construction on the Volga River and built the first hydroelectric power plant on the river in the 1930s (by the 1990s, eight major projects including dams, reservoirs, and hydroelectric facilities had been built); federal planners in the United States, beginning in the late 1920s embarked on a multipurpose approach to its water projects. The trend continued and by the 1940s, federal agencies had made the transition from single purpose development to multipurpose with support from programs such as President Harry Truman's "Fair Deal." This national conservation policy directly affected the Mississippi River as more locks and dams were constructed. My conclusions will wrestle with the relevance of political ideologies in comparison to the forces of modernization. A secondary theme will be the lingering influence both rivers have in their respective national culture and how populations reconcile their idealized images of the resource with contemporary development.

This proposed paper presentation is part of a larger project in that during the Fall semester 2003, I will be residing in Dubna, Russia on a Fulbright research/lecture award. A comparative study of the Mississippi and Volga Rivers is the purpose of the Fulbright award.

D. Water Management in the Nile Basin

099. Roberta Camera, Valeri Cogan & Gretel Gambarelli, Italy

The influence of the international co-operation on the review of the Nile River Management.

This paper explores the evolution of Egyptian water policy during the last decades, in the context of a threatening water scarcity, transboundary water conflicts and international co-operation. Water scarcity is one of the main problems to be faced by many Mediterranean countries in this century. This applies even for countries that have traditionally had sufficient water resources to meet the needs of their societies. Population growth, increasing tourism, industrial development and growing living standards are the basis of an increasing water demand. This water demand has started to become an almost continuously increasing pressure on renewable - as well as non - renewable water resources. Water conflicts are very likely to arise in water stressed areas between countries that share the same limited resources. International co-operation becomes thus the only alternative to water wars. It also often represents the only way to gain access to consistent financial support from foreign national governments, international organisations and NGO's.

In Egypt, during the last decades, water supply from Nile River and the High Nile Dam Lake have represented an abundant and reliable water source. Nevertheless, the water resources in Egypt are subject to an increasing pressure. During the last 50 years, the population of Egypt has tripled, inducing thus a big impact on the growth of water demand. Apart from Nile River, other water resources are represented by non renewable groundwater in the deserts and small amounts of rainfall in the northern coastal area and in Sinai. Therefore, Egypt will face great challenges in managing water resources in the near future.

The first part of the paper consists of a brief excursus on the evolution of water resources management in Egypt since the building of the Aswan High Dam in 1975 up to now. The second step consists of exploring the important influence of international co-operation on Egyptian water policy. The most recent example of this influence is the Nile Basin Initiative Process, a new agreement among the Nile Basin riparian states, which will redistribute the river's water use rights in a more equitable way. Supported by the World Bank, the United Nations and several European countries, the plan aims at laying the foundations of the river's economic development. Cairo's decision to co-operate seems to contradict Egypt's historical conduct, characterised by its monopoly over the river. This decision seems to be motivated by the country's need of economic development.

165. Declan Conway, UK

From Headwater Tributaries to International River Basin: Environmental Change in the Nile Basin.

Rivers draining large river basins integrate the interplay of change proximate and underlying drivers of environmental and societal processes across a range of scales. Whilst the results of some activities may not directly affect the runoff process, many aspects of environmental change may alter river characteristics. The temporal and spatial scales at which many processes of change occur will be important for understanding the downstream consequences of upstream change. Incremental changes across time and space may cancel out certain effects or begin to cumulatively affect runoff and river flow characteristics at detectable levels against baseline conditions. The Nile basin is used here as a geographical unit to explore processes of environmental change acting across a range of spatial and temporal scales.

The paper considers three environmental change phenomena manifest in the headwaters of the Nile basin: land cover and land use change in the upper Blue Nile basin; soil erosion and downstream reservoir sedimentation in Ethiopia and Sudan; and historical climate variability and future climate change in the headwaters of the White and Blue Niles. The focus will be primarily, but not wholly, on tributaries draining the Ethiopian Highlands which contribute around 70% of overall Nile discharge. The aim is to explore change that is manifest locally but with regional and even international consequences through its effects on Nile river characteristics.

Prior to the end of the Dergue regime in 1991 there was very little published empirical research on environment in Ethiopia whilst the last decade has seen a significant increase in research and publications on this theme. Post 1991 much of the research and many publications have taken a questioning and even revisionist approach to earlier understanding and perceptions of environmental change. The results of empirical process studies of soil erosion, land degradation and land cover change

have significantly broadened the knowledge base and understanding of contemporary rates of change and the complex interplay of human activities. As research findings accumulate the picture that emerges is one of complexity that undermines many of the assumptions and generalisations that were widely circulated in the 1980s and early 1990s. Progress in these areas will be discussed in relation to scale and downstream effects.

New and updated analysis of rainfall records for the two key source areas of Nile flow, the Ethiopian highlands (around 70%) and Lake Victoria region (around 15%) highlight the magnitude and importance of climate variability for local, regional and international water resources management. Decadal variability in Ethiopian highlands rainfall has driven marked fluctuations in downstream Nile flows, with a particularly dry period from 1978-1987. At regional and local scales very dry years and sequences of dry years have been associated with significant acute food security events which are superimposed on longer-term chronic food security problems in the highlands. In the Lake Victoria (White Nile) system extreme wet years and secular increases in October-November rainfall, combined with amplification and storage effects of hydrological systems, especially Lake Victoria, have led to prolonged large shifts in lake levels and river flows with important consequences for water resources management. The potential impacts and high level of uncertainty associated with projections of future climate change underscores the need to manage water prudently with careful consideration of uncertainty in both future supply and demand for Nile waters.

Finally the paper will use the complexity of these examples to explore the linkages between local-level environmental change in the Nile headwaters and their implications for understanding environmental change at the larger scale of the Nile basin.

198. Magdy Hefny, Egypt

Toward a Framework for Localizing COMSET's Global Ethical Guidelines in Egypt and Africa Region

In 1998, the World Commission on the ethics of Scientific Knowledge and Technology (COMSET) was established. A resolution, to that effect, passed at the 29th session of UNESCO's General Conference. Special attention has been given by COMSET to freshwater along other vital areas of energy and information technology, for which three working groups were established to investigate and research into their field, within specific mandate.

By the time of convening the forthcoming IWHA 3rd Conference in Cairo in December 2003, five years have elapsed. And there is a rich and varied body of discussions and documentation, emanated from intensive work of the working groups and panels of eminent scholars and experts. The aim of this paper is to highlight the work of the Sub-Commission on Water, and suggests a framework for localizing such valuable water ethics initiative on the national and regional Africa level. It is timely and of special importance, to have a candid discussion and better reflection, on issues involved in building such a framework for localizing COMSET's global ethical guidelines in Egypt and Africa Region, for which this conference is best suited.

H.E. Mrs. Vigdis Finnbogadottir, Chairperson of COMSET, has aptly explained that "ethics can be simply defined as an attempt to evaluate choices from essentially human perspective" (COMSET, proceedings, Oslo, Norway, April 1990). She has guided the work of the Sub-Commission on Water by putting several questions to investigate, inter alia,

- how to balance the right to water as a prerequisite for life with the right of ownership,
- how to agree on preventing contamination or selfish exploitation of a shared basic resource,
- access to freshwater has increasingly been identified as a major potential threat to world peace in this century.

In Aswan, Egypt, the Water Sub-Commission under the patronage of H.E. Mrs Susan Mubarak, the First Lady of Egypt and Member of the COMSET met in November, 2000. The theme of the Conference was entitled: "Towards Ethical Guidelines for the Use of Freshwater". The Report made reference to aspects of water as an ethical issue and concluded with guiding principles on the global level on: consuming water, protecting water, and distributing water. The question, here, in this paper is how best such ethical guidelines could be initiated and applied on the national and regional Africa level.

It is encouraging that, "Global Research and Ethical Network Embracing Water" (RENEW) has been created. And node points of RENEW started to take shape in some geographic regions. The program for such a node would embrace all aspects of water, and have "Bottom-Up" education / communication functions, as well as "Top-Down" high level research aspects, with industry participation. RENEW also includes best examples of ethical practices in all aspects of freshwater use. These activities are of special interest to the node point for Africa region and its future programme of work.

In October, 2002 an International Conference was held in "Bibliotheca Alexandrina" on Ethical and Social

Responsibilities in Science and Technology. A special Committee addressed, among other issues, ethics on freshwater and emphasized the importance of initiating and localizing the guiding principles for water as an ethical issue.

These developments and issues raised in the paper ranges from conceptualizing and building a framework for localizing the Global Freshwater Guidelines, to issues of capacity building, processes of social learning through better participation of different water research centers, education, water suppliers, water regulators, industrial and agricultural users, organizations concerned with information and exchange and dissemination.

It well emphasized by Mr. Koichiro Matsuura, the Director General of UNESCO, in his message on World Water Day 2000:

"The challenge we face... is to set in motion a dynamic that will make this the century of world water security. Water has long been too low on the public policy agenda... We need to take a constructive approach to water; it is an essential, shared resource; it should be treated as foremost priority in every community from local to the global"

164. Nicholas S. Hopkins, USA/Egypt

Water conservation in Egypt: a socio-historical analysis

Thoughtful Egyptians are beginning to realize that water conservation is essential for the future water supply of Egypt. The per capita amount of renewable fresh water in Egypt is now just under 1000 cubic meters, generally taken as marking the scarcity level, and will decline as population rises. Virtually all of Egypt's water comes from the Nile, and is part of accords and relations with other Nile basin countries (Waterbury, The Nile Basin, 2002). Roughly 85% of Egypt's water is used in agriculture, with the rest divided between industry and domestic use. In this context, what is the role and future of water conservation?

Any substantial savings must come from agriculture, the biggest user. To some extent this depends on high-level decisions (for instance, on the engineering aspects of the irrigation system, or the cultivation of a water-demanding crop like sugar cane). But also much of it depends on the actions of the myriad of small farmers in the Nile valley. This paper thus examines the practices and behavior of farmers with regard to water use and misuse. A key part of this debate is the issue of getting farmers to pay for irrigation water (they currently do not): why and how. Use of water for irrigation also implies drainage, and thus we must examine the different ways in which farmers categorize and use water. As the rural population grows, disposal of solid and liquid waste becomes more of a problem; the traditional solution of dumping waste in a canal with running water no longer suffices.

Urban dwellers also have a role to play in water conservation. There is a considerable literature on how water is acquired and used in poor urban neighborhoods, and disposal of waste water is also a problem (Hopkins, et al, People and Pollution, 2001). Water management in the household is a factor. Factories also use a good deal of water.

Most plans for conserving water in Egypt require substantial social participation. Yet this is not easy in Egypt, where most forms of social mobilization contravene the emergency laws and disturb the authorities. People may wonder why they should economize on water when their neighbors do not. This paper examines water conservation strategies at the household level in urban and rural areas, and suggests improvements. At the same time it examines the major choices in agriculture, and notably efforts to persuade farmers to use water more efficiently - through improved technology, pricing, and the like. The paper concludes with an effort to use present trends to peer into the future.

059. Sintayehu Kassaye Alemu, Ethiopia

The Hydropolitical History of the Abbay River

A brief insight of the hydro political history of the Ethiopian Abbay (Blue Nile) river is presented in connection with the three countries that claim the water in common. These are Ethiopia, Egypt and the Sudan. The Ethiopian Abbay River, together with the two tributary rivers of Tekeze and Gash, contributes 86% of the total water of Nile proper. From this total amount, the share of the Blue Nile (Abbay) is 59%. The remaining 14% of the waters of the Nile belongs to the White Nile. The magnitude of the utilization of the Abbay-Nile waters by the major concerned countries: Egypt, Sudan and Ethiopia-is much more different and unequal. For the Egyptians Nile means everything. It has been and still is the base of every

facet of the development of their life: agriculture, civilization, religion, calendar, writing, and urbanization from time immemorial. Hence, it is not surprising if Egyptians voraciously associated themselves and their foreign polices with the Abbay-Nile waters. The Sudanese also equally exploited the Abbay-Nile waters almost beginning from the same time. The first Sudanese "basin irrigation" system was started at about 3000 B.C. The Sudanese continued to utilize the Abbay-Nile waters with an increasing mechanism and demand. Most of their dams are constructed on the Abbay waters. The Sennar Dam, that irrigated an area of 300,000 feddans in the Gezira, is solely constructed on the Ethiopian Abbay or the Blue Nile river.

On the other hand, Ethiopia who claimed Abbay River as her natural gift, remained, for a long period of time, impotent to utilize her waters. The reasons are many and complex. But the major causes are her backwardness and continuous internal and external wars. In one way or another, until recently; Ethiopia's utilization of the Abbay water is limited to the construction of very small and traditional dams built by some farmers living around the river. These conditions, the utilization of the Abbay-Nile waters by the Egyptians and the Sudanese from earlier times and Ethiopia's impotence to use the water gave the two former countries a "historical right" to exploit the water unilaterally. This unequal and unfair utilization of the Abbay-Nile Waters became the source of confrontation and conflict particularly between Ethiopia and Egypt beginning from the middle ages.

The Ethio-Egyptian historical relations were, to a significant extent, shaped by the Abbay. To guarantee the use and control of the Abbay waters, Egyptians made an attempt to conquer Ethiopia in the 1870s. This idea of conquest was partially realized by the British conquest of Egypt herself and other riparian countries of the White Nile in the 1880s. This episode also inaugurated formal agreements and sanctions over the Abbay-Nile Waters. For example the Ethiopian government was sanctioned, by an agreement signed in 1902, not "to arrest the flow of their waters into the Nile" in one-way or another. In addition to these agreements, Egypt and the Sudan also made cooperative alliances, supported by "legal" documents, to use the Abbay-Nile Waters without the participation of the rest of the riparian states. They signed the Nile Waters Treaty in 1959. The latter agreement is the functional document until today. Today because of population increase, draught and question of sovereignty, the other riparian states, above all Ethiopia, are strongly demanding the equitable and fare utilization of the Abbay-Nile Waters. And some promising steps have been taken towards cooperation and mutual exploitation of the waters.

Finally, it is suggested that all the riparian countries better utilize the underused Abbay-Nile Waters, peacefully, cooperatively and fairly for the betterment of their poverty-stricken population. All riparian countries have enough war experiences and clearly knew the fate of war. All should work honestly towards the peaceful exploitation of the waters. And their own people and the international community should support this effort as well. For these, all the riparian countries and in this particular case Ethiopia, Egypt and the Sudan should feel responsibility for their people and work for cooperative exploitation of the Abbay-Nile waters. At the same time Egypt and the Sudan should be ready to repeal the 1959 Nile Waters Treaty and replace it by a much more inclusive and fair agreements.

123. Jonatan Krzywinski, Norway

Roman Water Supply in the Eastern Desert of Egypt.

The Ptolomaic/Roman activity in the ED in antiquity required a considerable amount of water. Gold mines, trade routes and quarries can be found all through the desert. All these activities require huge amount of water presumably collected from wells, but new research indicates that waterharvesting methods may have been used. Pollen associated with agricultural activity was found together with desert vegetation in samples from mud bricks found all through the area. Seeds from cucumber and other vegetables were found in the French excavations at the quarries at Mons Claudianus. Digs here and at Roman waystations along the caravan routes from Coptos to Myoshormos also revealed ostraca (sherds with writing) wich refer to growing vegetables. I consider the evidence for desert farming together with the severe shortage of water as suggesting that waterharvesting may have been an alternative strategy. Flooding in the wadis is normal and water harvesting is normal further south in Sudan. Huge hafirs (man-made dams to trap runoff water) are found in ancient Meroe. Other waterharvesting methods were well known in the Roman world. The project`s goal is to reveal harvesting structures related to the Roman ruins in the ED and to calculate the amount of water likely to have been trapped.

127. B. Mintesinot, W. Kifle & T. Leulseged, Ethiopia

Harnessing the water resource potential of the Tekeze basin: achievements, challenges and prospects

This paper addresses the major issues related to water resource development and management in the Tekeze basin (which is part of the Nile basin), with implications to sustainable water management in the fragile environments of northern Ethiopia. The Tekeze basin is generally represented by high variability (spatial and temporal) of rainfall, resulting in chronic food insecurity. Moreover, water levels in wells are getting very sensitive to the rainfall variability. Geohydrologically, most of the aquifers in the basin are characterized by shallow unconfined types, with thickness up to 50 meters.

In the last years, the Ethiopian government has been undertaking a number of activities such as construction of micro-dams, ponds, diversions and other surface water harvesting schemes in the Tekeze basin. In areas where there has been intensive surface water harvesting activities, a number of positive trends are recorded, such as an increase in the discharge of springs and recharge of groundwater systems, and an improvement in the quality of spring and groundwater. Moreover, there is an improvement in the food security of the local farmers as well as water supply for livestock and domestic consumption. The micro-climate and vegetation systems are also found to improve in those areas where water harvesting activities are in place. The regional implication of this intervention is increasing base flow, improving the macro-climate, and enhancing the water security for livestock and domestic consumptions. Though a number of positive trends are recorded, there are challenges to the present water development practices in the basin, including siltation/sedimentation of the reservoirs, improper use and management of irrigation water, and salinity problems. For sustainable water development and management in the Tekeze basin and in other areas of the northern Ethiopia it is advisable to employ the conjunctive use of water development, apply proper sedimentation /siltation hazard assessment and mitigation measures, and address the problems related to salinity and irrigation water management.

092. Hala F. Nassar & Stuart Echols, USA

Canals and Ponds of Cairo: Influence of traditional Water system on the development of Cairo's Urban Form.

Cairo's medieval urban form cannot be separated from water resource management in the Nile Basin. The city evolved in direct symbiotic relationships to flood management, crop production and the enrichment of urban life. The system of canals and lakes developed in Cairo created a unique perspective on sustainable city planning that grew from a civilization that was dependent on and inimitably responsive to natural aquatic systems. These processes resulted a planned and yet ephemeral city that would change its physical form, urban structure and social character each year with the opening of the Khalig. Changes in outlook, however, resulted in the transformation of the landscape under Mohammed Ali with the filling of the numerous canals, lakes and ponds, which once characterized the landscape of Cairo. As a result, the urban pleasures of spending nights on or near the waterways, strolling the promenades listening to musicians, being entertained by dancers or celebrating the cutting of the Khalig with feast and fireworks can only be imagined by current city dwellers.

This paper explains how water planning was inextricably linked with urban planning to play a pivotal role in the design and daily life of Cairo and examines the unique water planning and city design including philosophical understandings, centralized planning objectives, societal requirements and cultural context. Implications for current land planning and design are derived the case study of Cairo and the unique design solutions that evolved from conflicting, as well as, symbiotic interactions between the built environment and natural ecosystems. This paper suggest that there is much to be learned by examining the processes that led to its intricate design and that there are many opportunities in current urban design to combine water resources management with city planning that would enrich city life, protect property, reduce municipal infrastructure cost, and protect our natural aquatic environments.

194. Zeydan, Bakenaz A., Egypt

The Nile River Basin in a Global Vision

The Nile is one of the world's great rivers. For millennia, this unique waterway has nourished varied livelihoods, an array of ecosystems, and a rich diversity of cultures. As the world's longest river, it traverses nearly 6,700 kilometers, covering more than 35 degrees of latitude and draining an area of over 3 million square kilometers; one tenth of Africa's total land mass. It is a basin of varied landscapes, with high mountains, tropical forests, woodlands, lakes, savannas, wetlands, arid lands, and deserts, culminating in a vast delta on the Mediterranean Sea. It is generally agreed that the Nile has several sources. The principle streams are the White Nile, which begins in the Great Lakes region of Central Africa; and the Blue Nile (Abbay) and the Atbara (Tekeze), both flowing from the Abyssinian highlands. The most distant source is the Kagera River, which winds its way through Burundi, Rwanda, Tanzania and Uganda into Lake Victoria.

The Nile River is shared by ten countries; Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda. The basin contains outstanding environmental assets, such as Lake Victoria, the second largest fresh water body by area in the world, and the vast wetlands of the Sudd. It also serves as home to an estimated 160 million people within the boundaries of the basin, while about twice that number, roughly 300 million, live within the ten countries that share and depend on Nile waters.

Despite the extraordinary natural endowments and rich cultural history of the Nile Basin, its people face considerable challenges. Today, the basin is characterized by poverty, political instability, rapid population growth, and environmental degradation. Four of the Nile riparian countries are among the world's ten poorest, with per capita incomes in the range of USD 100-200 per year. Population is expected to double within the next 25 years, placing additional strain on scarce water and other natural resources. In a historic step, the riparian countries jointly established a Cooperative Framework to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources.

The present study highlights the state of the art in the River Basin studies that are related to historical, social, economical, geographical, hydrological, water rights, and water management aspects.