Inter-Sectoral Water Allocation: A Case Study in Upper Bagmati Basin[1]

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INTRODUCTION

The use, allocation and management of water in the Bagmati Basin occur under the influence of natural, societal and other factors. Population growth, expanding urbanization, growth of polluting industries, rising land prices, ineffective governmental policies, overlapping and often contradictory legislation and policies and declining motivation for collective actions have exacerbated the stress on water use and alloction. Competition among water uses is rising and conflicts have started to emerge, particularly during the dry season. Domestic and industrial wastes are rarely treated; instead they are discharged raw into water bodies. Untreated wastes greatly lower the quality of river water and jeopardize the health of populations living downstream or close to the source of discharge. The cost of water pollution to the environment and to the society is high, with rising cases of water brone diseases. One major consequence is increased stress on the social fabric, including conflicts over the allocation of safe water.

The exact nature of the competition and of the stress that will emerge, however, is not adequately understood. Also the impact cannot be predicted with accuracy as the institutional processes are in different stages of evolution. Generally, the quality and quantity of water supply are on the decline both at local and regional levels. Though the effects are harsher for those at social and economic margins, the impacts pervade across the social spectrum. This situation is an outcome of the complex interplay between the physical nature of the resources, the role of the formal state agencies, government departments and informal fanners and community groups, including the increasing litany of acts and regulations. Though several initiatives on policy formulation have been made, in the current socio-political milieu, they have not been translated into action and have failed to show results. The outcome has been further rising competition over use of water, lack of effective formal management, encroachment of customary norms and the degradation of the quality of water.

An understanding of the processes by which water is allocated to meet various needs is important if improvements are to be made and a decent level of service is to be delivered regularly. The problem of deficient services does not, however, stem from the fact that the quantity of water is lacking or that the technology for tapping water is not available. Rather, the problem is rooted in the absence of a social and institutional framework to ensure that services are delivered. In many cases, the rate of deterioration is fast, and the challenges of improving the services appear to be even more intractable. A solution will come from an approach aimed at setting institutional processes on track rather than one honing purely technological tools.

OBJECTIVES AND METHODOLOGY

The primary objective of this paper is to obtain insight into the society-water interface in Kathmandu Valley which is synonymous with the Upper Bagmati Basin, and to offer some explanations of the nature of the emerging competition for water. More specifically the paper will attempt to provide some insights into the issues governing inter-sectoral allocation of water with respect to a) different water uses, b) the nature of both formal and customary water rights, and c) the role of institutions with respect to (a) and (b). It aims to describe

a) the status of different water uses;
b) the nature of the relationship between customary and statutory water rights;
c) the nature of the competition for, and conflicts over, access to and use of water; and
d) the role of institutions in water management;

The study is based on field study of two sites in the Upper Bagmati Basin, Mahankalphant and Jorpati/Gokarna region northeast of Kathmandu city. a review of "gray literature"[3] and on an analysis of secondary information. The study of Mahankalphant aimed to understand how the economic and political strength of the capital city is leading to encroachment of the customary rights of the population in terms of access to water. In Jorpati. the other case study site, efforts were made to explore interface of customary practices with state-led and commercial initiatives. Because decisions about management occur within a complex social context, discussion are made keeping the larger framework in the background. Ethno-ecological methods were used in both case studies. It must be mentioned that sources are disparate and data inconsistent. In this report, the area occupied by Kathmandu Valley will be referred to as the Bagmati basin and the case study region as the sub-basin.[4] The Gokarna/Jorpati region will be referred to as Jorpati.

This paper first describes the case study sites and the nature of the water resources base. It then dwells on the types of institutions both in the formal and informal sectors that manage water. The analysis of the drinking water sector is done in greater detail because of its increasing dominance. The Acts, Rules and Regulations are dicussed next. The description of the nature of the sectoral uses is followed by analysis of the changes and impacts in relation to the case studies. Finally, conclusions are drawn. It is hoped that the finding will assist in the identification of options for the management of the inter-sectoral allocation of water.

This paper is one part of an on-going study of the changes that are occurring in Kathmandu. It aims at some understanding of the complex social, physical and historical/political factors that are at work shaping water use and availability in the Valley. It is not about comprehensive literature review, elaborate field investigation or exhaustive scientific modeling. If it stimulates further questions to refine the knowledge of the complexity, this effort will have been amply rewarded.

THE RESEARCH AREA

The region analyzed in this research is the Upper Bagmati Basin northeast of Kathmandu city including Mahankalphant and Jorpati villages. This region was selected for study because of its long history of state-led interventions and the current competition between at least four water use sectors: agriculture (irrigation), hydropower, drinking water for urban and rural communities as well as industry (carpet factories). The major water use elements analyzed are the Sundarijal Hydropower Plant; a farmer managed irrigation system at Mahankalphant in Sundarijal; Kathmandu's drinking water production system in the sub-basin: surface water and groundwater systems; an agency developed imgation system and carpet factories in Jorpati. References are also made to the rural drinking water supply systems in the sub-basin and to riparian uses. The Bagmati basin and sub-hasin, the case study areas and the systems elements which were studied are shown in Figure 1(a) and I (b). Water use elements are shown schematically in Figure 2.

In Sundarijal, a hydropower plant has been built and water from its tail race feeds Kathmandu's water supply system. A small patch of irrigated land called Mahankalphant is situated on the eastern bank of the Bagmati, opposite the power plant in Sundarijal. The land supports about ***50*** families of diverse ethnic composition, though the majority are Tamangs. Mahankalphant is a typical rural community though it is located in the Valley. The other site analyzed in this study is lorpati, which is closer to Kathmandu and therefore, more influenced by the creeping urbanization. The Jorpati suburban region has registered gradual changes in its land-use pattern as new settlements, particularly along the road corridor have developed. A number of carpet factories, which use the municipal as well as groundwater sources, have been built in the area.

The Jorpati region is served by the imgation barrage at Gokarna. The barrage, built by the Department of Irrigation (DoI), irrigates farmland on the west and east banks of the Bagmati River. The total command area was 152 ha, ***55*** ha of which is on the eastern side. The eastern canal is managed by the farmers and operates intermittently, while the western one is no longer functional. The western canal is filled with liquid and solid wastes in several places and has been encroached upon by the road and factories. Besides the eastern canal, other smaller, temporary diversions also extract water from the river and use it for irrigation. The irrigation canal at Jorpati was also used for other purpose. Water powered, cereal grinding mills, known as *ghattas,* were installed in places where the gradient of the canal changed suddenly. In the ***1950s*** there were I0 or 12 *ghattas* in the canal at lorpati. With the increasing availability of electricity and ground cereal in the market, the operation of these *ghattas* declined, and has long ceased to operate.

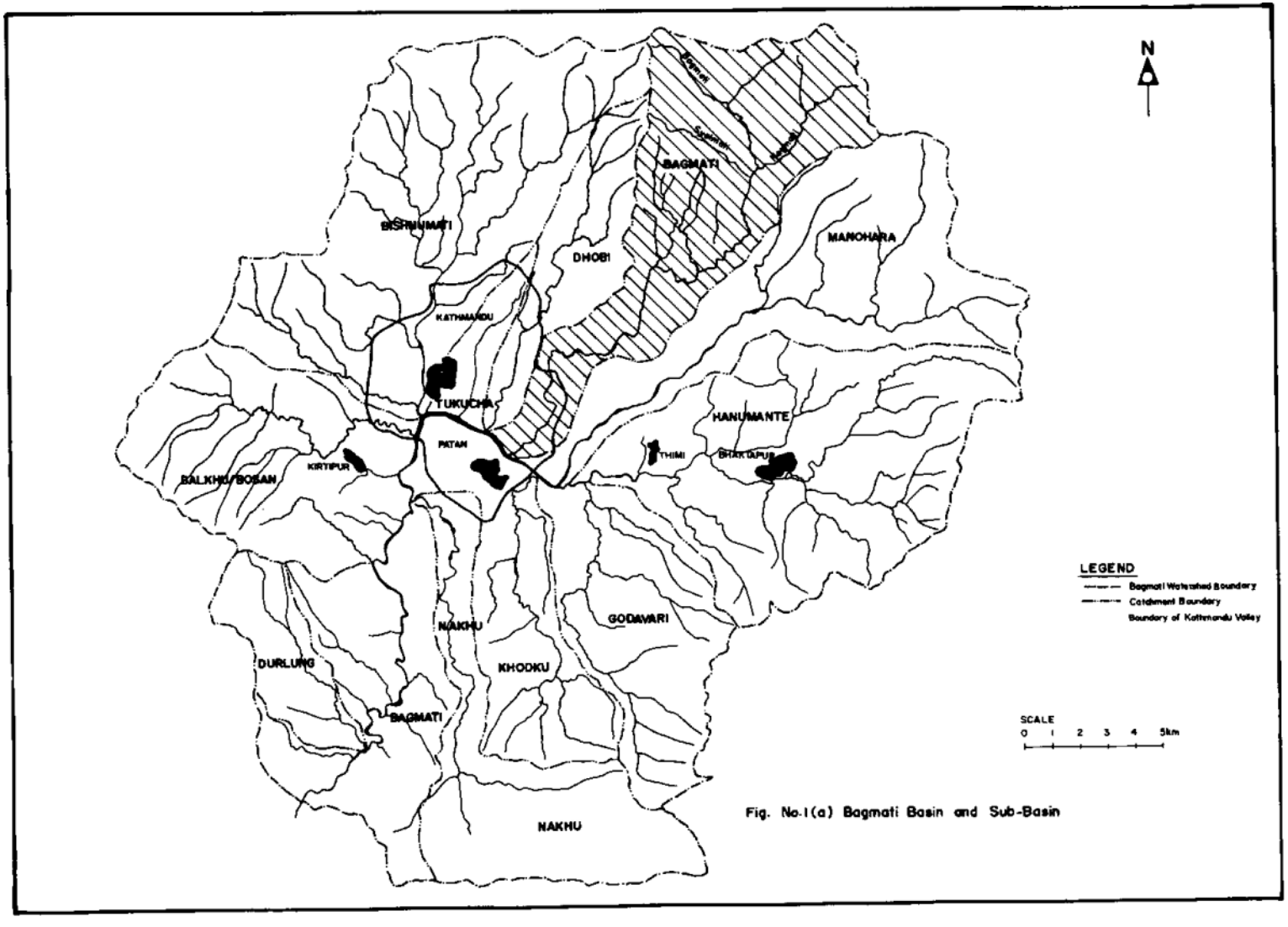

Fig. No.1(a) Bagmati Basin and Sub-Basin

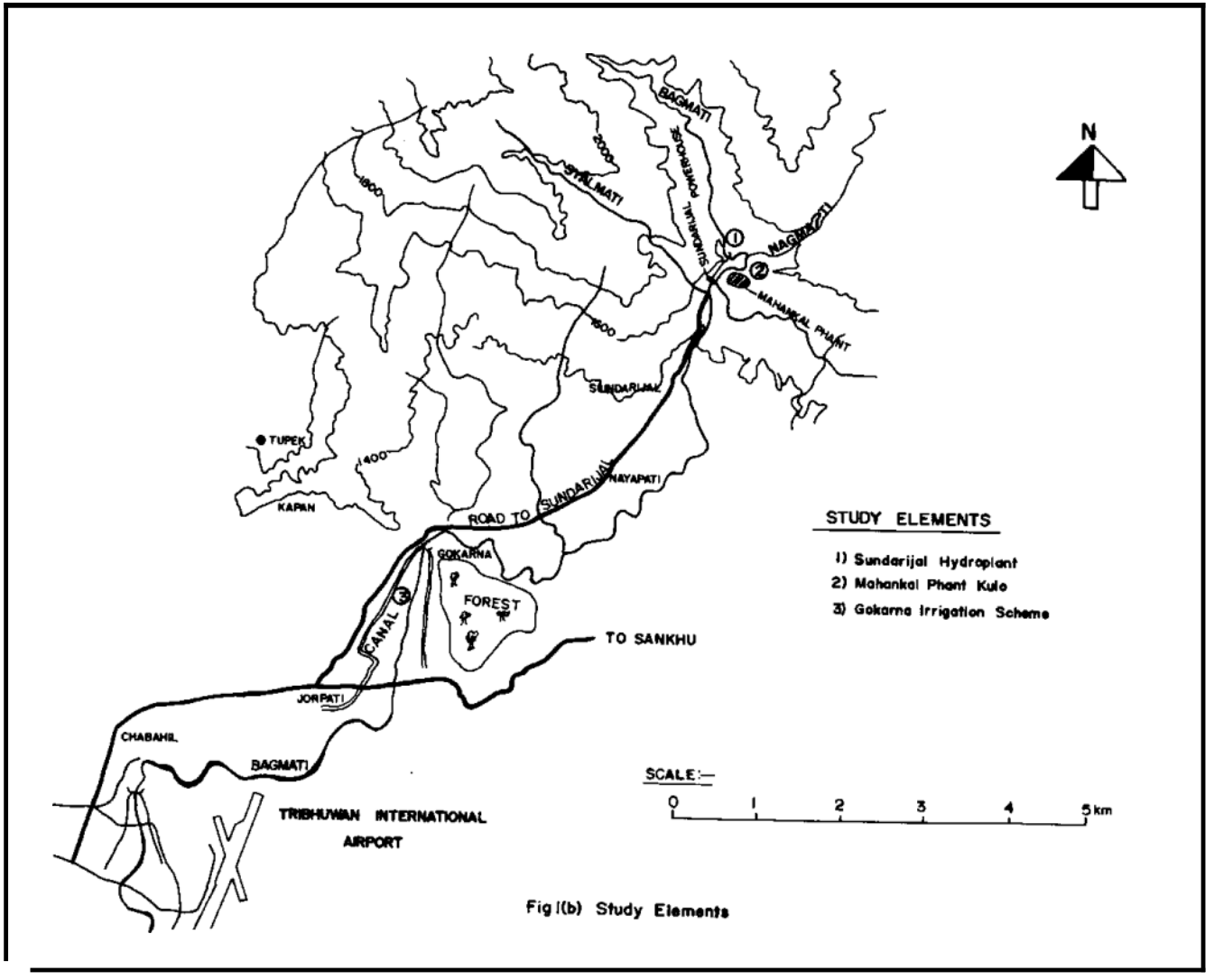

Fig 1(b) Study Elements

SCHEMATIC OF WATER USERS IN UPPER BAGMATI BASIN

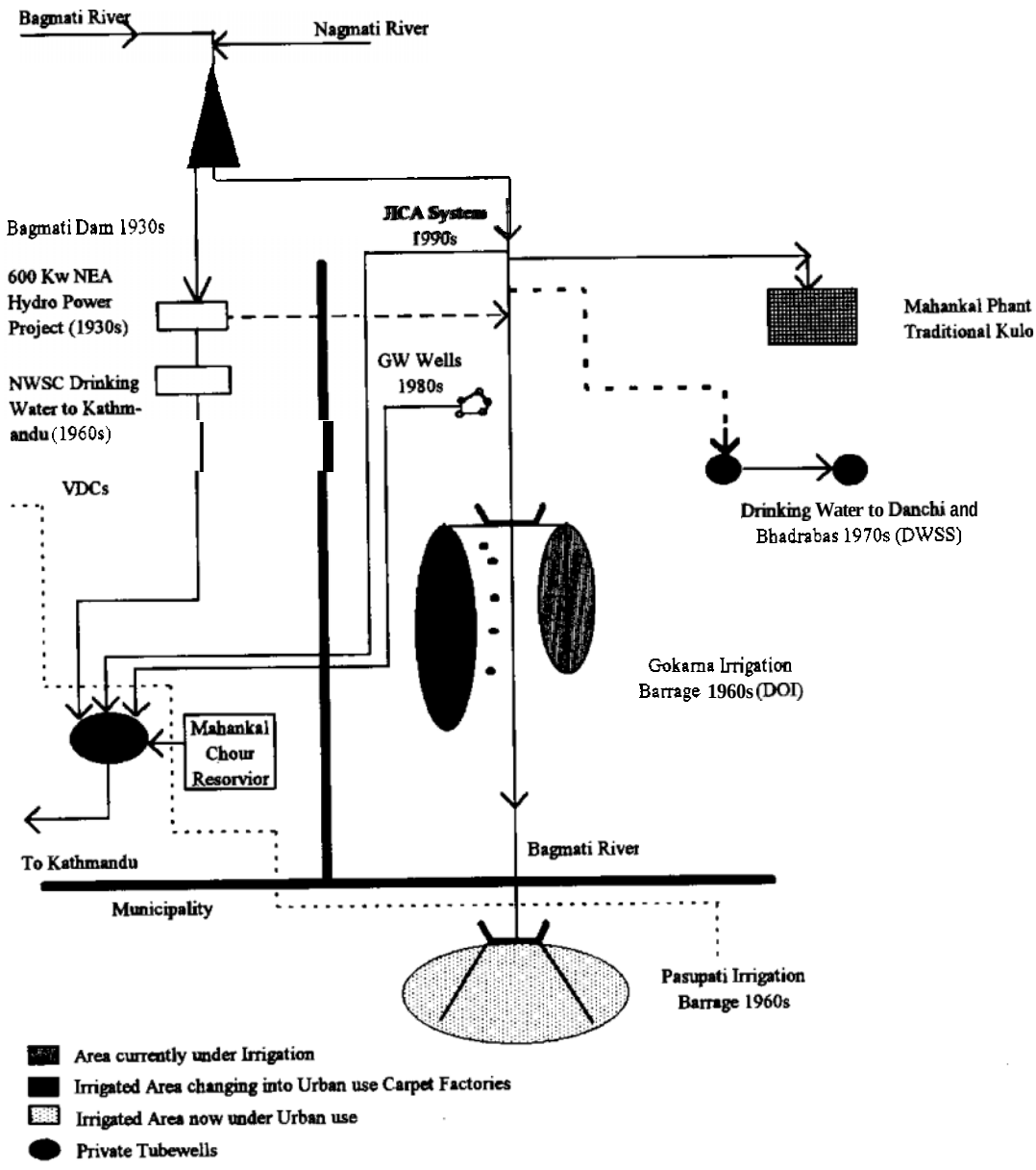

Figure 2. **Schematic Drawing of Water Use Elements**

The Resource Base

The Bagmati River originates in the south-eastern flanks of Shivapuri Hills which form the part of Mahabharat Hills. Fed by rainfall and base-flow, the river drains a total area of 3710 km^2 in Nepal, and then joins the Ganga river in India. Its upper basin, where Kathmandu Valley is situated, occupies an area of 662 km^2 until the river flows out of the valley at Chovar. The valley and its inhabitants are dependent on the rivers of the monsoon-fed basin for meeting all their water needs. Rain falls in the basin during the pre-monsoon months of April and May, during the monsoon months (between June to September), and in winter. Almost 80 percent of the annual rain which falls in the Bagmati Basin occurs during the monsoon months. In a year, Kathmandu Valley receives a mean rainfall of about 1900 mm, but this figures varies between 1100 and 2500 mm from year to year.

The flow of the Bagmati River is directly influenced by the rainfall pattem, and it is during the four months of the monsoon that almost 80 percent of all run-off occurs. At Chovar, the mean annual flow of the Bagmati is about 15.5 m^3/s. Run-off is governed by the volume, duration and intensity of rainfall, and evaporation. Even during the monsoon, fluctuations are high and the flow does not show a direct correlation with rainfall. In the dry season, the minimum average flow at Chovar is 0.51 m^3/s. The flow at Chovar does not, however, measure actual discharge; upstream extraction takeaway some of the flow. Interception of return flow from the tributaries and the main river and reuse of that flow is frequent and widespread. The volume of water thus used depends on how much land can be irrigated and the availability of water. The latter is particularly limiting in the dry months when use exceeds availability. Assessment of actual use of return flow and consequently obtain the estimate of the natural flow is, therefore, complex. Because the volume used is not monitored, and water tax records are not maintained,[5] it is almost impossible to quantify the amount of water used by the irrigation sector.

The floor of the valley has resulted in a geo-hydrological formation with both shallow and deep aquifers.[6] The three deep groundwater aquifer districts are the northern, central and southern. Because only the northern aquifer is hydraulically connected to the surface sources, it exhibits some natural recharge characteristics. The sub-basin investigated in this report includes part of the northern aquifer. In the southern and the central aquifers, which are both overlain by a thick layer of clay, natural recharge is low.[7] The occurrence of shallow groundwater is widespread, but the quality of groundwater fluctuates seasonally and varies by location. In many cases, shallow groundwater is unsuitable for consumption.[8] Since the 1980s, groundwater, from both deep and shallow aquifers has played an important role in fulfilling water requirements in the Bagmati basin.

INSTITUTIONS MANAGING WATER

The formal institution present in the sub-basin is His Majesty's Government of Nepal whose policies and programs are executed through departments and para-statals. The four departments which are directly related to the use of the water resources come under the Ministry of Water Resources: the Water and Energy Commission Secretariat (WECS), the Department of Irrigation

(DoI), the Groundwater Resources Development Board (GWRDB), which monitors groundwater investigation andexploitation, and the Department of Hydrology and Meteorology (DHM), which is in charge of the collection of hydrological and climatological data.

Another organization is the Nepal Electricity Authority (NEA), a para-statal chaired by the Minister of Water Resources and responsible for hydro-power development and electricity supply. NEA owns and operates the hydropower plant at Sundarijal. Though in principle, the DoI is responsible for all irrigation activities within the valley, only a few schemes were built by the department. In practice, most irrigation schemes are built and managed by farmers with little or no linkage with the DoI. These farmer-built systems have existed for centuries and generally did not find salience in formal discourse till the early 1980s.

Theagency that has the major role in the use and management of water of the sub-basin is the Nepal Water Supply Corporation (NWSC). It is a para-statal established under the Ministry of Housing and Physical Planning (MHPP) by the Nepal Water Supply Corporation Act of 1989. The previous incarnations of this corporation were the Water Supply and Sewerage Corporation (WSSC), and the Water Supply and Sewerage Board (WSSB) and the Pani Goswara. which was the entity established by the Ranas when thefirstpiped watersystemswasbuiltuntil the World Bank entered the scene in 1974 and created the WSSB, then the WSSC. At present, the corporation supplies water to 13 municipalities of the country including Kathmandu, Bhaktapur and Lalitpur in the valley. As a para-statal, NWSC has the advantage of having some autonomy over its income but it has problems collecting revenue and devolving management. It has shown a penchant for procuring and disbursing funds through investment in infrastructure rather than water management.[9] The water treatment facility at Sundarijal and the groundwater wells are under the ownership of NWSC.

The Department of Water Supply and Sanitation (DWSS) has the most extensive mandate and handles watersupply inruralareasas well as in a number of major urban centers. The responsibility for supplying drinking water to the and to rural villages in the sub-basin out side of NWSC lies with the DWSS. In the ten yearperiodfrom 1980 to 1990, it wasorientedtowards theconstruction of drinking water projects. Before 1980 DWSS was responsible for providing water supplies to all rural communities in the hills and mountains with population in excess of 1500people, and to develop shallow groundwater potential within the Terai belt.[10] The creation of the Rural Water Supply and Sanitation Fund Development Board in 1996 has emerged as a competitor of the DWSS. The board evolved *Jakapas*, a World-Bank funded pilot initiative, to support water supply to settlements with less than 500 residents.

The Ministry of Agriculture (MoA) and the Ministry for Land Reform will have more prominent roles to play as demographic changes continue in the valley, and competition between urban and rural interests in the use of land and water resources increase. At present, however, there are no links between agricultural development, land zoning and classification, and water management. The Ministry of Local Development (MLD) deals withlocal development activities including the administration and coordination of local bodies. District, municipal. and Village Development Committees (VDCs) function under the umbrella of the MLD. These committees are empowered by their legislative mandate to develop and manage water supplies and other amenities at the local level. Other agencies active in the Bagmati basin are the municipalities of Kathmandu, Lalitpur and Bhaktapur, which provide urban services at the local level.[11] The study region falls under the

jurisdiction of Village Development Committees and the municipality has no legal presence here. Informal fanner's groups and community organizations exist both in Mahankalphant and in Jorpati. But while a healthy collective spirit is maintained at Mahankalphant, particularly in irrigation water application, at Jorpati this spirit is on the verge of becoming extinct. **A** recent development in the study region **is** the emergence of registered non-governmental groups. Most of the groups give themselves a broad mandate to support environmental activities and social services rather than just to focus on water management issues.

Formal organizations have not been effective in addressing the question of rising competition, nor in resolving the conflicting demands resulting from the limited supply and diminishing quality of water. The functions of the formal and informal institutios overlap, as there is no dividing line where the duty of one ends, and that of the other starts. The outcome is clear: inabilitytoadjudicate the inter-sectoral allocation of water in the face of rising scarcity due to increasing requirements, changing use and deteriorating quality. Efforts at maintaining water supply have, in fact, led to more stress.

EXPANDING REGULATIONS

The intervention **of** the state has also occurred indierctly by means of promulgation of laws and policies. The entry of the state through its various organs has been associated with concomitant promulgation ofdifferent acts, lawsandregulations that support and seek tojustify the roleofstate organizations thus established for harnessing and management of water. Collectively the effect of these laws has been encroachment on customary practices of water management, degeneration of the resource and theresultant accentuation of the dichotomy between the capital city and the rural areas. The state has encroached on customary (local) rights and rules which are also articulated in the country's National Code (*Mulki Ain*).[12] These codes include mechanisms for upholding customary norms and for indirectly governing water management. particularly irrigation systems. Since the early nineteenth century, when the country embarked upon modern development, private land ownership has increased and land tenurial relations have changed, which have also affected the practices **of** water management and allocation.

A major legislative initiative was the Canal, Electricity, and Related Water Resource Act of 1967. The promulgation **of** this Act can be explained as an attempt by the state to introduce specific legislation governing utilization of the country's water resources. *The* Act articulated a new role for the state by initiating the creation of infrastructure in pursuance of the stated development goals. Development activities were undertaken by government departments and bodies such as the Development Boards established under the Act. Though the Act of 1967 recognized the right of individuals and groups to construct irrigation schemes, the right of eminent domain was manifest. The Act stipulated that authority to control irrigation facilities rested with the state once it had investedin the creation ofsuchfacilities. The paramountpower ofthestateover existing irrigation systems if they "hindered" government actions was evident in the Act, which also incorporated the concepts of licensing, payment of irrigation service fees, and so on. As a result, the customary rights of the users had meaning only **as** long **as** they were legitimized by the state.

This Act, which was never really implemented, was amendment and finally replaced for several reasons: the proliferation of development activities, the emergence of competition for the use of water, the availability of new technological option for water extraction, and conflicts over uses. Three new legislations were introduced in 1990s: the Water Resources Act 1992 (WRA), the Electricity Act 1992 (EA) and the Water Resources Regulation of 1993. The WRA which attempted to cover all aspects of water resource development replaced the Canal, Electricity and Related Water Resources Act of 1967. The WRA aimed to address the rights involved in the hierarchy of water use, privatization, and public interest, and to ensure optimal use of the resources. The WRA also includes groundwater as one of its components.

A flagship act of the Ministry of Water Resources, WRA was the first act in Nepal to stipulate that ownership of all water resources within the kingdom of Nepal is vested with the state. It requires that licenses must he acquired to use water. The Act ensures water right and provides for the prescription of a pollution tolerance limit as well for systems for monitoring pollution. It also allows for water user's groups to be formally registered under it. While the Act is filled with appropriate words, it is actually in conflict with other acts because it duplicates their mandate. There **is** also a gap in legal coverage particularly because the formal registration **of** community users' groups is done under the Society Registration Act and not the WRA. The thousands of fanners groups have not found it worthwhile lo bring themselves under the umbrella of the Act, as it would mean curtailment of their autonomy.

Under the Act, the allocation of water resources is decided as seen fit by the ministry. Allocation takes the form of permission to make new interventions for development and of right of expropriation of water to agencies, communities. the private sector and individuals. Right to use water is provided through licensing, though free access of water for certain uses "granted". In the case of facilities regulated hy public agencies or private developers, the individuals rights are subservient to the terms and conditions imposed by the state through the concerned agencies. Since the right of "ownership" is treated as the paramount right of the state and other rights, such as usufructuary rights, and transfer rights, as derivative or secondary to ownership rights, the difference between "people's rights" and "states rights" have become more apparent than before.[13]

The WRA also stipulates the principle of beneficial use of water hy prioritizing uses, presumably according to a hierarchy of needs. The need for drinking water precedes all other needs. The Act also authorizes the government to utilize or develop water resources on its own and stipulates that for purpose of extensive public uses, the state can develop and acquire water resources, land, buildings equipment, and related structures to be utilized under the Act. It makes provisions for conflict resolution; arbitration **is** to he achieved through a prescribed committee. However, the procedure for appointing the committee and the definition of its mandate are vague. The nature of prescribed right remains unclear. Although the responsibility for discharging the Act lies within its jurisdiction, the Ministry of Water Resources has not yet followed its mandate as stipulated in the Act. The act is enforceable when a gazetted notice "specifies" the area where the provisions of the act is to be implemented, but no such area have been specified or licence issued.

CHANGES IN WATER USES

History

Water was one of the main elements of the *Lichhavi* and *Malla* civilizations in Kathmandu Valley. For its domestic water supply, the urban core had dhunge ydharos, stone spouts built in a depressed rectilinear pit with an ingenious system of water filter and supply hydraulics. Wells were dug and natural springs exploited. These water supply systems were locally managed. For irrigation, stream water was diverted by constructing temporary dams to divert water into earthen canal, and then into fields. The canals were managed using traditional systems with a history of cultural and religious continuity. The operation and management of many irrigation canals received state sanction and support; these canal were called raj *kulos* (state canals). Fertile soil and fresh water from the numerous streams and wells made it possible to farm intensively in the valley floor and the surrounding hills.

With the start of Rana rule in 1840 AD. the compact urban form of the earlier era and water management institutions gradually came under stress. Rana rulers occupied agricultural land outside the urban core where they constructed Victorian style stucco palaces. The domestication of water for private use, as opposed to the prevailing communal use, acompanied other changes that started 40 years after the Rana s came to power. During the reign of Bir Sumsher, the third Rana Prime Minister, water sources in the northern Sivapuri hill were tapped and transmitted by pipe networks to the capital. The water system was built primarily to provide water to the Prime Minister's palace but was also available to the ruling elite. When the Rana oligarchy was overthrown in 1951, new lifestyles were disseminated more rapidly among the local inhabitants which resulted in the increased use of piped water for private household activities and other uses.

The deliberate policy of the Ranas to restrict migration into the valley and its inaccessibility had deterred large-scale migration into the valley. After 1950, these restrictions began to ease. Kathmandu became more accessible to other parts of Nepal when the Tribhuvan Highway, which connected Kathmandu Valley to Hetauda in the south, was completed. The completion of other highways linking Kathmandu with other parts of Nepal further improved accessibility to the valley. Improvements in accessibility have resulted in the concentration of administrative, commercial, industrial and educational activities in the valley. People from all over the country began to move to the valley leading to a rapid increase in its population. This, in turn. has induced a positive feedback resulting in the mushrooming of settlements, garment and carpet factories and other manufacturing enterprises in the capital.[14]

The nature, scale and pace of urban expansion since the 1950s generally, but more specifically since the 1980s, have accelerated the breakdown of the religious-cultural milieu of the valley. At the same time, the existing infrastructure facililties have not been able to cope with the changes and have deteriorated. For example, the water supply distribution system in urban Kathmandu is inadequate; it requires major repairs and, in many cases, replacements. The volume of water lost from the system is increasing. Despite substantial resources spent on improving the services, the decline in services has continued.

Sectoral Uses of Water: Current

In Kathmandu Valley, water is used for many purposes. These are (i) irrigation, (ii) drinking water, (iii) hydropower, and (iv) industrial use, (v) house construction and (vi) religion. The Bagmati and its tributaries are important for a variety of both seasonal and perennial religious rituals, ranging from feasting and bathing at auspicious occasions *(Kushe Auncee)* to cremation of the dead and death rituals involving ablution. In this paper we will discuss only the first four uses of water.

In the Upper Bagmati Basin the state has intervened on several occasions by constructing hydropower plants, irrigation barrages, expanding drinking water system and so on (See Table I).

Table **I: Sequence of Interventions**

Year of Intervention	Nature of Intervention
1936	Hydropower plant
1960s	Drinking water system expansion through tapping of tailrace from hydro-plant diversion of the Bagmati River
1960	Irrigation barrages at Gokarna and Pashupatinath
1970	Drinking water systems upgrading (World Bank project)
1980	Groundwater wells development
1994	Wet season Bagmati flow brought to Mahankalchaur (JIC project)

Hydropower Development

The first state-led intervention in the Bagmati sub-basin was the construction of the 640 *kW* hydropower plant in the 1930s. The plant diverted water from the Bagmati to generate power. A dam was built in the Bagmati River upstream from its confluence with the Nagmati River above Sundarijal. The dam created a small reservoir from which water was channeled through a pen-stock pipe to the power house below the reservoir located on the downstream bank of the river. After power was generated the water was released into the Bagmati River via the tail-race of the plant.

Though the power plant made non-consumptive use of water, diversion of the river flow soon started to have a negative impact at the local level. Water flow during the lean season for irrigation at Mahankalphant was reduced. The plant did release the diverted water back into the Bagmati river, but at a point lower than the irrigation intake. Consequently, flow into the intake decreased. Residual flow from the main dam and the flow from Nagmati. a tributary of Bagmati provided a water supply in excess of the requirements of the farmers except during droughts when irrigation needs weren't always met. The flow from the tail-race of the plant, later was divereted to meet drinking water needs of Kathmandu.

Irrigation

Prior to the 1950s, the flood-plain along the Bagmati river was used exclusively for agriculture. Irrigated agriculture was the dominant institution to use and manage water. In terms of volume, even today irrigation is thegreatest water user. The locally built irrigation systems consist of *syauli* (brushwood) dams to divert water. After diversion, water is conveyed through an earthen *kulo* (canal) and supplied to a series of terraced fields with diverse ownership. These temporary dams are made of stones, hushes and logs. Generally clay is used to provide a seal. Re-erecting the dam requires that the farmers benefiting from the system come together to perform the needed restorations.

The processes and activities related to the diversion of water and its provision to multiple users are governed by traditional management practices and communal understanding. Water for irrigation is distributed from the head to the end of the canal. The flow from one terrace finds its way into the next. and the next, and finally to the main river where water is used again.[15] The plantation of rice, the major crop, is completed in less than two weeks. lrrigation is required mostly for supplemental applications which serves the interests of all the farmers. These processes in general describe the procedure of water allocation in a fanners managed irrigation systems, which was also evident at Mahankalphant, Only in the dry season when the water flow was naturally lower and in the season of rice seedlings transplantation did the situation tend to become stressful both at Jorpati and Mahankalphant.

The state-led initiative to develop irrigation in the sub-region began in the early 1960's, when two irrigation barrages were constructed replacing the temporary structures. One was built at Gokarna and the other at Tilganga close to the temple of Pasupatinath. After the barrage at Gokarna was completed, the existing farmer built canal was rehabilitated and extended to Boudha. which is currently Ward No.7 of Kathmandumunicipality.The barrage at Tilganga irrigated land along the eastern and western banks of the Bagmati river along the track lying south of the present bridge over the Bagmati river near Gaushala at the Ring Road. However, this barrage has no irrigation function presently

The Department of Irrigation (DoI) organized a formal mechanism for the maintenance of the barrage by appointing caretakers ("*dhalpa*"). The *dhalpas* operated the barrage gates, ensured a constant supply of water in the canals, and supervised maintenance. Until 1984, farmers were active in canal maintenance, even though the responsibility rested with the Department of Irrigation. Departmental involvement in canal maintenance gradually declined, and fueled by the increasing challenges of maintenance, the interest of the farmersalso declined. The entry of carpet factories into the area propelled land speculation and for many land owners, it has become more profitable to sell or lease land than to maintain its agricultural use. The *dhalpa* arrangement for maintainance was dismantled in 1990when the new Irrigation Policy came into effect.[16]

Drinking Water

Urban Use

Piped drinking water was introduced in Kathmandu as early as the 1880s, when the Bir Dhara system was built. The system tapped the headwaters of the Bishunumati river in the Shivapuri hills.

Later, in the 1930s the Tri-Bhim Dhara system, which utilized the spring water source in Balaju, was built. The third major intervention for improving drinking water systems in the capital, but only the second intervention in the Bagmati sub-basin, was made in the mid-1960s. Water from the tail-race of the Sundarijal Hydropower Plant was tapped in order to supply water to Kathmandu. Raw water from the tail-race was treated in Sundarijal and then transmitted to a reservoir in Mahankalchaur north of Kathmandu city. Almost all of the lean season flow of the Bagmati River upstream of Sundarijal was tapped. Still later, Nagmati and Syalmati, the two tributaries of the Bagmati in the sub-basins, were also tapped.

The early drinking water supply systems served a small percentage of Kathmandu's population, mostly those living in the central core. By 1990, however the reticulation system had expanded into a network that served the population living in an area of 50 km^2 mostly within the Ring Road. At present seven water production systems serve seven major sectors in the distribution area. Though for the purpose of analysis, the supply network may be divided into identifiable sectors, the reticulation is actually a complicated system of mains and distribution pipes that overlap and intermix among the sectors. Pipes that were laid a hundred year ago also constitute part of the reticulation system.

The rapid urban expansion over the last few decades has resulted in haphazard growth and the expansion ofdrinking water reticulation system has not matched the growth of new settlements.[17] As result, water supply connection to new households are mainly from one major distribution mains. The result is the widespread incidence of manifold supplies called spaghetti connections.[18] Old pipes and spaghetti connections are some of the reasons for the exceptionally high losses of water that is supplied. Because of high losses in the transmission lines, distribution systems as well as wasteful use, only of 40-60 percent of the supply fed into the system is actually available for consumption.[19] The estimates of unaccounted for water is uncertain and also vary, because bulk water use metering is not done.

In the sub basin, second major intervention to improve the drinking water system was initiated in 1974. Its objective was to provide safe and uninterrupted supply of drinking water to the residents of Kathmandu.[20] The initiative came under the program funded by a World Bank loan. All earlier supply systems had used surface sources, which were considered to be inadequate, and rather unreliable for industrial use, particularly during the dry seasons. The exploitation of groundwater started in the early 1980s, again under the third loan package from the World Bank. From virtually nothing, the contribution of groundwater to Kathmandu's drinking water supply had reached between 40 and 50 percent of the total dry season supply by 1995.

Inthedecade between 1980 and 1990 private pumps in large numbers have beeninstalled athotels, commercial establishments, industries, government offices and international agencies. Private wells were also installed in the Jorpati region by factory owners. Nayapati, in Gokarna VDC, has five deep pumps which feed water to the Mahankalchaur reservoir. The groundwater extraction rate far surpasses the rate of natural recharge. Thus the resource is mined from the acquifer lenses rather than harvested. Also, the groundwater has a highconcentration of ammonia, manganese and iron. Since 1995, the NWSC has started to use groundwater only in the dry season when surface flow is insufficient to meet consumers demand by combining surface water and groundwater supplies.[21]

In 1994,a project was undertaken with Japanese assistance to improve the quality of groundwater. The project constructed a treatment facility at Mahankalchaur. A new transmission line parallel to the one existing from Sundarijal to Mahankalchaur was also laid. The purpose of the new line was to tap the wet season flow of the Bagmati River. The new transmission line transfers raw water from the river to Mahankalchaur, where it is treated and supplied to Kathmandu. The new system makes further encroachment on the traditional water rights of the users there.

Despite these efforts and initiatives, the drinking water supply service is deficient both in terms of quality and quantity. Supply is intermittent, available only for 3 hours each in the morning and evening on the average. In several parts of the destribution area, there is no supply for days. The fluctuating flow has resulted in a situation in which contaminated water is sucked into pipes during periods when the supply under pressure is not maintained. This problem is particularly serious in the inner city where drinking water supply pipes and sewer lines are laid almost parallel to one another, but also in the sub-urban regions. Initiatives on maintaining the systems have been delayed, and existing proposals have been bogged down by delays in negotiation of the terms of the loan and other details.[22]

Rural Use

The rural population in the sub-basin also use the Bagmati River and its tributaries as its source of drinking water. The population in Danchi, Thali, Bhadrabas and Nayapati use the Bagmati as their source. The water system at Danchi takes water from the Mahankalphant irrigation *kulo* diversion. Its construction was sanctioned by HMG in the early 1980s. When asked why they allowed this water source to the used by others, the farmers of Mahankalphant responded that drinking water is more crucial than irrigation and therefore, it has to he shared. Water in the rural areas is supplied by community tapstands, and the per-capita water demand is rated at 45 liters daily. The actual figure of consumption of water is not very easy to estimate because large number of those living in these villages move daily to Kathmandu to perform wage labour, do marketing or work in government offices where they work. As part of the floating population they also draw on the municipal services there.

Industrial Use

The use of flood plains along the banks of Bagmati and its tributary rivers in the Kathmandu began to change away from agricultural use at a fast rate in the late 1970s. The changes have been more evident as growth of ribbon settlement along the roads in general. The situation was not much different in the Jorpati region in the sub-basin, which saw increasing growth of settlements. Particularly in Jorpati area, carpet factories began to appear around the mid 1980s. The carpet industry was taken up on a large scale and was to become the major foreign exchange earner of the country. Most of the factories are located along the road, while many others are located along the western canal that is fed hy the Gokarna irrigation barrage.

There are several reasons why carpet establishments are concentrated in the Jorpati region. One reason was the presence of a Tibetan community who possessed carpet making skills.[23] Other reasons are vehicular access and a reliable water supply due to the proximity of the trunk main from Sundarijal to Mahankalchaur as well as more stable groundwater aquifers. The suburb of Jorpati is in the center of the northern groundwater distnct of the valley. As carpet manufacturing requires

significant water, it was natural for entrepreneurs to seek a region which ensured a good water supply and thus posed fewer risks to business.

The transmission main that brings treated water from Sundarijal to Mahankalchaur provided a reliable source of water supply. Even those factories located close to the Gokarna canal, further away from the transmission main, used it as their water source. Supply was obtained by tapping directly into the mains in direct violation of the existing regulation of one connections per premise. Some factories were able to obtain between two to five connections. The factories had access to continuous water supply, 24 hours a day even when services in the city became deficient. Many of these connections were freely provided, and larger size pipes than usually installed for domestic supply were used.[24]

Factories are located within compounds, and include a work area and living quarters for the employees. In Jorpati area, however, factories generally perform weaving, dyeing and washing.[25] The population of workers in the factories ranges between 50 to 500. It was reported that, in the 1960s the region had 1300 households and 1700 voters.[26] In the decade from 1980 to 1990, the population increased almost by ten fold. The expansion of carpet making activities is another reason for the floating population of migrants in the valley which has further increased pressure on municipal water supply.

Other Changes

Land **Use**

The continued use of upstream sources for fulfilling drinking water needs of Kathmandu has reduced availability of water in the Bagmati river. Declining flow has meant that water was not sufficeint for irrigation, and consequently interest of the farmers at Jorpati for agriculture is on the decline. Availability of a continuous and comparatively reliable water supply at Jorpati — groundwater and piped supply, including some residual flow in Bagmati — has led to the establishment of several carpet factories there. Establishment of factories in turn brought migrants looking for employment opportunities. which in turn impacted the irrigation systems whose operation had been affected by the declining river flow. Factoriy buildings and new construction activities have made further encroachment on the irrigation canal, particularly on the western side. Not only did the construction directly interfered with the canal, solid and liquid wastes from the factories were also dumped there, which blocked the canal flow. As a result, the Gokarna barrage irrigates only the eastern bank of the Bagmati River west of Gokarna forest.

Blocked canal and pollution have deterred the farmers from irrigation management and cultivation. In the short run, therefore, selling land is seen to be more profitable than cultivation. As the price of land in this area has risen steeply: in Jorpati one ***ropani*** (0.05 ha) is reported to fetch between five hundred thousand and one million rupees depending upon location of the plot, speculation is high. Many fanners reason that they can support themselves better by selling their land than by farming. To paraphrase the question posed by farmers, "Who would give up 500,000 rupees per ***ropani*** of land which produced meager agricultural harvests?". For those fanners who do have the capacity to sustain production, competition from cheaper goods imported from the Tarai has reduced the viability of vegetable farming as an occupation. The agricultural outputs

from the resultant small holdings can not support a family year round. Selling or leasing land has thus become more attractive, and the motivation for collective actions and irrigation management is on the wane.

Speculation on land is also high due to the nature of land ownership. Division of land among inheritors also leads to land fragmentation, and selling. The land in Gokarna phant of the Jorpati region belongs to a *guthi* (trust) of the Pasupatinath temple. Because of the common property characteristics of the *guthi* land, encroachment is on the rise. Consequently, new houses and settlements are mushrooming not just in the Jorpati region, but also on the suburban regions of Kathmandu. Theoutcome issimíliar generally. Agricultural lands in the flood plains have changed into settlements. The most dramatic changes is evident at Tilganga. The barrage there no longer serves its original function because its command area is now a compact settlement. Because, these settelements expand without adequate sanitation and water supply provision, there is net negative effects on water resources: deterioration of quality and quantity.

Sand Mining: Low River Bed

One outcome of the growth of settlements in Kathmandu has been an unprecedented demand for sand. Since the 1970s, sand has been mined from stretches along the Bagmati at a much greater rate than it is naturally replenished. Whileclearly changing the physical character of the river, sand mining alsohasan impact on local irrigation. Sandextractionaffectsirrigation two ways. Intensive sand quarrying, has lowered the river bed by between 1 and 2 meters in several sections. Because this has resulted in a lower water level, less watercanenter the canals. Due tosandmining the river bed is lower than the irrigable land so the brushwood dams have to be located further upstream. However, since water from further upstream reaches different land parcels, the management of water for agriculture has thus become more intractable.

Pollution and Waste

Pollution of surface water is mostly through biological waste, and is on the rise. Factories which are located along the roads and canals, where workers live, dispose waste directly into rivers, irrigation canals and land parcels. The reduced residual flow resulting from increasing upstream extraction means rivers are less able to assimilate and flush away untreated liquid wastes. The degradation of rivers in Kathmandu is the combined effects of, reduced residual flow due to upstream water extraction. mining of sand and disposal of untreated waste in water bodies.

The extent of biological pollution of groundwater is less pronounced. Deep aquifers, are not yet polluted because groundwater recharge occurs in the northern aquifer which is of good quality. Surface water quality here is comparitively better, but deteriorating. Though biological quality of deep groundwater is not really an issue at present, it will be soon if the trend of pollution of the upper reaches of the Bagmati in the sub-basin continues. In general shallow groundwater is so polluted that it can not be used for drinking, but the situation varies according the location of the aquifers and sub-soil seepage from household septic tanks. Pollution is likely to continue as it is easier and cheaper for industries to dump waste in rivers than to treat it. Lack of standards on housing, water and waste water will lead to further deteriorations. Even if standard are made,

because enforcement is weak, the situation will not change. Pollution mitigative initiatives, therefore, must be more holistic and make a begining from where waste is generated.

COMPETITION, CONFLICT AND DISPUTE RESOLUTION

Increase in population, urbanization, changing pattern of land-use, river bed mining for sand and increasing pollution are altering the conventional uses of water. Water traditionally used for irrigation, is now allocated for other uses, mostly drinking. The result is that almost all of the flow of the Bagmati River has been diverted and that the amount of water for downstream uses has become inadequate. Since 1994 expropriation of the wet flow as well as the dry reduced water availability even during the wet season. Tapping of the wet season flow was based on the logic that more surface water is available during the monsoon season. Now water is deficient the whole year, whereas in the past, water was short only in the *dry* season. The declining flow and limited supply of water has led to more frequent disputes among farmers. In some extreme cases, scuffles even took place, thus heightening tensions in what had been amicable social relationships.

Pollution has also exacerbated local level conflicts. Farmers in the Jorpati area believe the discharge of effluents from neighbouring carpet factories was the primary reason for damage to crops and reduced crop yields. Waste discharged into imgated fields is reported to have reduced yields between 2 and **5** times. Fanners reported that instead of rice, the produce was ***"bhus"*** (husk with no rice kernel inside) or ruined crops: the rice paddy did not mature properly, turned yellow, and died. The effects on both grain and vegetable crops irrigated with contaminated water are reported to be similar. Pollution from one particular factory in Jorpati was the cause of a dispute between farmers and factory owners (see below).[21]

In one case, the VDC filed a case with the district court against the building of some houses in the Jorpati region. The court ruled that VDCs have no authority to prevent construction activities within their administrative jurisdiction.[28] Their failure at getting the state to adjudicate has led the farmers to seek alternative forms of conflict resolution. Users seem to prefer non-formal forms of settlement. Industries too seem reluctant to trust the state apparatus for adjudication. This was evident in the conflict between factories and farmers at Jorpati in which case, the presence of a third party — a local NGO, was instrumental in bringing in settlement between the affected farmers and the polluting carpet factory. The negotiation bro ght compensation to the farmers. and in the process, the NGO also secured benefit for itself.[28]

There is no statutory mechanism for adjudication either between the departments and the users or among different users. In Jorpati it led to a situation of impasse. Several complaints about the damages in the canal made by farmers to the District Irrigation Office (DIO) went unheeded. Later in consultation with a local club, samples of the polluted soil and water were presented to the DIO and officials from DIO inspected the area. However, no action was taken. The DIO, in fact, refused to enter into any form of arbitration. The fanners were told by the District Irrigation Office, ***"There is no procedure for direct action,"*** in cases of pollution. The farmers also approached the Gokarna VDC and even met the then Minister for Water Resources, but without success.

The formal sector, including VDCs and departments, have not only been unable to resolve conflicts, but have also failed to respond to the situation of water stress at local levels. In response, farmers have devised ways that bypass official procedures. The need to compete has also been exacerbated by the hydropower plant. During the dry season, the same water used by the plant, though in limited quantities, is claimed by the Mahankalphant users for transplanting rice. Since local water rights are not respected, there is no official practice of releasing water from the plant for limited local use. The particular needs, however, are met by working on the local loayalties overriding the statutory provisions. Fanners approach the operators with their request and the operator in turn releasing the water for aperiod of 2 to **3** hours during the plantation.

Due to the poor level of coordination and the lack of interaction among the state agencies, departments and para-statals, the extent of competition is likely to be exacerbated during the non-monsoon months. Following the promulgation of the Water Resources Act, the state is now the primeadjudicatorinresolving waterrelated disputes, hut hashistorically tended to ignorethe non-state. In several cases, the state has failed to adjudicatejustly. Thus at one level state intervention is expanding. By assuming control over the customary practices of water management, it has exercised resolution of authority. At an other level, however, the state is also weak. There are many instances in which state agencies have succumbed to collective assertions and bargains. When the collective bargaining strength of a local community is strong, such as when farmers organize themselves in a group, state agencies are forced to respond even if **it** means that the water use priority accorded by Act has to be contradicted upon. [30]

In a situation of conflict, particularly when the questions of ownership and rights of surface water between the departments, para-statals and informal groups of farmers, the issue of equitable allocation remains unresolved. Such conflict may hinder in meeting drinking/industrial and irrigation water needs. During peak irrigation seasons the same water source may he claimed by farmers asserting prior utilization rights. If left unresolved, transmission lines may be broken and water used for rice transplanting. While affecting the drinking water supply to the target community, issue of unresolved ownership **is** likely to exacerbate the conflict over equitable allocation of water.

ENCROACHMENT OF CUSTOMARY RIGHTS

At Mahankalphant, in the study region, it was reported that those erecting the brushwood dam had first right *to* irrigation, and those cleaning the canals had second priority. This practice conforms to customary law: those who erect diversions for irrigation have top priority over the use of the water source. Farmers at the head end of the canal were first to use the water, while those at the tail end last. The customary law isnotrecognizedby the 1992 Water Resources Act, which accords priority to drinking water use of a domestic user or group of users who could claim right over existing use.

The Act accords absolute recognition of the state's ownership and control of water resources. It empowers the government with the authority to issue licenses for water allocation and to resolve conflicts over water use, if and when they arise. Although the Act requires all users to claim their

rights lo the water sources they are using, no such claims have been expressed either by the state agencies or para-statal organizations that already use water sources. The stipulations of the Act and the customary practices in many case as evident from the case study are likely to lead to a situation of conflict. The relevance of the 1992 Water Resources Act vis-à-vis the customary parctices and practical operational requirements need review.

The right of the state to own of water resources which is stipulated in WRA, may not affect the daily activities of fanners using an irrigation system. Also absence of departmental programmes as well as budgetary constraints may limit the role that state agencies have in the management systems. However, the promulgation of each legislation necessitates a reconciling of customary laws and practices with conventional concepts of water development and modem legal system. The result is that customary rules are gradually eroded.[31] Now that the balance of power has shifted in favour of the state, there is a risk that the state's prowess will prevail over the "right" of a community, user or group of users. The chance of eminent domain being exercised is increasing in the face of rising competition, conflict and adjudication over access to water.

In the Irrigation Policy of 1992, reference is frequently made to the legal recognition of water users groups as autonomous entities, to the respective rights and duties of the users and the irrigation agency, to placing systems under collective ownership of the users, to handing over full ownership of systems built by agencies to users, to having and the related structures be kept at water users' associations registered by the government, and to give the responsibility for operation and maintenance activities as well as for defining of ownership. However, nowhere in the policy is the question of water rights considered or the rights and including other operational concerns of owners acknowledged. Under the provisions of the policy, HMG/N does not envisage that irrigation development in Nepal will remain exclusively under government ownership, which contradicts the stipulation of the WRA which places all water sources within the jurisdiction of the state.

Thus, right to water seeems to be assured to those who already have access to services as prescribed by the new Acts. To those who are yet to be provided with the services, the obligatoin of the state has not been made clear and is a question that remains to be addressed. For example, the existing rights to irrigation water at Mahankalphant was continously encroached upon to meet drinking water requirements of the capital city. There has been no efforts to prescribe the water right of the comminity there to a share of the river. Though the 1990 Water Resources Act requires that rights for use of water have to be claimed, none has been done by the NWSC or NEA both of which use the Bagmati river's water.

CONCLUSION

The water allocation and management problems in the Upper Bagmati Basin are a result of a complex combination of factors that include not only the availability of water resources and their vulnerability, but also demographic, legal, administrative, commercial, political and behavioral issues. In the past problems were expected to go away when more water was made available. This has not been the case and, in fact, the level of service continues to deteriorate. The deficiencies

result from institutional weaknesses and a lack of clarity about how water use and rights are to be allocated both formally and informally. Segmental operation of government departments and agencies have led to deterioration of the level of services.

Customary water rights are being encroached upon by a configuration of forces which are dominantly urban in character and commercial in orientation. While the current policies mention managing water through decentralized initiatives, the respect for local water rights needed to sustain such astrategy is lukewarm at best. The importance of decentralized management of water resources has not yet been ideologically internalized by mainstream socio-political processes. The usurpation of resources and lack of decentralization initiatives have important implications in the pursuance of the goal of achieving national well-being through providing water for improved health, food, security and energy.

Since water resources themselves are decentralized their management should also have a decentralized framework instead of the centralized bureaucaratic approach currently in vogue. Decisions about resource allocation have to be made as close to the source of consumption as possible. At no level, either in local village governments or central departments, has the mandate to issue permits for use and to adjudicate allocations of water been made clear. Who should supervise allocation and using what mechanism to preserve the tolerance limit of water are unanswered issues. In the current decision making structure, the question to answer is: How will thechanges to ensure the equitable allocation andmanagement of wateroccur, and who will bring about these changes?

It is unlikely changes will come from the pyramidal departments which constitutes only one sub-setofthesocialenvironrnentinvolved in themanagement of water. A department is maneuverable by political pressures and itself does not possesses an inborn vision to institute change or to consider the broader implications of its activities. Because water utilities have to sustain the purpose for which they have been created, they show inclinations towards rejecting arguments that question their style of functioning. This hostility stems more from the fear of loosing legitimacy than from the injustice of the criticisms.

The results are clear. In spite of the huge sums of money spent on delivering water, the supply in Kathmandu isdeficient and allocation is unsustainahle. Thereason has less to do with watersupply projects or technical solutions themselves, than with the model ofdevelopment that has flourished in the capital city. When the size and growth of Kathmandu are juxtaposed with the limit of its in-valley water sources it is clear thatexpansionofthecity is unsustainable. Whilecontinuoussupply servicesbyinterbasintransferofsnow fed river would add to the quantum of water, the population served in Greater Kathmandu is expected to be close to 3 million in 2015 AD, when the project would be completed. One can only guess at the impact of this population in a city in which the social limits on population havealready been reached. Limited investigations in Kathmandushow that the social costs are high, especially to the uneducated, those living at the social margins, women, children and, from a broad perspective, the next generation.[32]

In summary, the preceding analysis provides following lessons. The competition among different water use sectors is on the rise, but the understanding of the nature of the competition is rather inadequate to allow equitable allocations. The expanding framework of Rules, Acts and Regulationsgradually encroachon thecustomary pratices and rights to water of the local community. The

role of the state, through creation of more legislations and Acts, is increasingly becoming dominant in relation to decision on how water resources will be used and allocated. The tendency of the governmental agencies to centralize is concomitantly associated with organisational conservatism, inflexibility and inefficiency. These attributes, at the level of individual organizations, continue to reinforce behaviour that perpetuates propensity towards traditions, caution and protectionism. In managing inter-sectoral allocation of water between the various sectoral agencies, adhocism thus pervades without reconciliation of the strategic mission of equitable management of water allocation with organizational culture. An unintended consequence of this apparent impasse is creation of social space that the communities have used to stake claim and receive their share of water, albeit only during the critical dry periods.

NOTES

1 This is a revised version of the paper read at the Workshop on "Water Rights, Conflicts and Policy", Kathmandu, January 22-24, 1996. Research for this paper was done under contract with IIMI/Nepal. The author wishes to thank Rajendra Pradhan, Dipak Gyawali and Sudhirendra Sharma for their comments on the paper at different stages.

2 Ajaya Dixit is water resource engineer. He is editor of the journal **Wafer** Nepal and chairman of Nepal Water Conservation Foundation.

3 Unpublished project reports and documents are referred to as "gray literature".

4 The (VDC) Village Development Comittee is the basic politicalunitofvillageadministration. VDCs consist of members elected by each of the nine wards in a village. The committee hasachairmanand vice-chairman elected by the VDC constituencies. In the VDC, activity plans and budgets are prepared and later approved by the DDC. A District Development Committee (DDC) is composed of representatives indirectly elected by the committee members, chairman and vice-chairman of VDC. The DDC includes Chief District Officer (CDO) appointed by the Home Ministry and local Development Officer (LDO) appointed by the Ministry of Local Development.

5 BBWMS 1994.

6 Till 1977, farmers in Jorpati area paid Rs 3 as *pani pot* (water tax), they no longer do so. If *pani pot* were still collected and the record had been maintained, the area under irrigation could be worked out as could the amount of water used.

7 JICA 1990.

8 Estimates of the recharge rate range from 30 to 40 Million Litres/Day (MLD), but even 27 MLD/Day is suggested as a plausible rate. See Binnie 1989. In 1987, HMG commission had questioned the provision of using groundwater on an assumed higher recharge as earlier studies had mentioned rather low recharge rate of 4 MLD/Day. See Pokharel Commission 1987.

9 For discussions on the availability and quality of shallow groundwater see Karmacharya and Rao 1990.

10 In a review undertaken for UNDP, Gyawali and Dixit 1994 analyzed institutional shortcomings related to the management of water in urban towns of Nepal under the NWSC. Many of these recommendations for the decentralization of management to local bodies remain to be implemented. Also see IDA I993 and Pokharel Commission 1987.

11 **MWR** 1981.

12 Each municipality is an elected body constituted under the Municipality Act of 2048 (1991) and

governed by a municipal board comprised of elected ward chairmen. The municipality is presided over by a mayor and assisted by a deputy mayor, both of whom are elected. The functions of a municipality are loosely organized, generally along sectoral lines such as tax and revenuecollection, issuance of building construction permits, planning and engineering, sanitation and solid waste management. administration and accounts, litigation. and inspection.

13 The customary law as enshrined in the *Mulki Ain* has beenineffectsince 1853(Regmi 1976). Under this provision. the state specifically recognises those who have priority in the use of irrigation water by implying that gains should accrue to those who had, through collective labour mobilisation, invested in the irrigation development first. *See* Pradhan 1993 for discussions on the nature of property rights in Nepal.

14 Pradhan 1993.

15 In migration has resulted in a population growth rate within the valley far in excess of the national growth rate of 2.5 percent. In 1991, the valley had a population of 1 million, while that of urban Kathmandu was close to 6 hundred thousand. See BBWMS 1994 for more details. The fact that large portion of the rural population comes to Kathmandu each day and returns to their villages in the evening demonstrate that the rural-urban communities are a continuum rather than distinct entities. See **INFRAS** 1993 for discussions.

16 In some unusual cases waste water from households is diverted for irrigation.

17 Once the Irrigation Policy was promulgated the Department of Irrigation (DoI) introduced the concept of joint management by users' committees (*upabokta samiti*) and thedepartment. This policy which was formulated following pilot tests in several regions. was undertaken to offset the financial burden of the cost of operation and maintenance to the government and to facilitate the role af the private sector in the development of irrigation. Under the provision of this policy HMG/N does not envisage irrigation development in Nepal to remain exclusively under government ownership.

18 Drinking water is suppliedtoanestimatedfive hundred andeighty thousandusers viaprivateas well as public tap stands by the NWCS. This estimate, however, does not include the large floating population in Kathmandu, which also seems to draw on the same supply of wafer. Only 80% of the consumers of NWSC are estimated have access to its services. Also, 80% was for domestic purposes (Binnie 1989). Another study by JICA (1990) estimated 81% consumption was for domestic purposes, 12% commercial for use and 5 % for industrial use.

19 Spaghetti connections are multiplicity ofdomestic supply lines from a single distributary. and are one of the causes of high losses of water.

20 Theestimates ofunaccountedfor water is uncertain and also vary. Studies by Binnie (1989) estimated that the loss was 65% In another study CES (1991) estimated the loss lo be between 40% to 50% while another study (JICA 1990) indicated that losses were perhaps only 30% of the daily production. The uncertainty remains. Officially 40 percent is accepted, but appears to rather a be politically correct figure. See Dixit A. 1992. A recently completed leakdetection study concludes similarly about high leak in the system, see IDA 1995.

21 The World Bank-supported first Water Supply Project was started in 1974. In 1978 the second loan package was approved, and the third package followed in 1984. See Pokharel Commission 1987.

22 BPC 1995.

23 Presently the World Bank and the NWSC are engaged in an institutional debate over the approval of a 60 million dollar package loan for the rehabilitation of the Kathmandu's drinking water system. Recommendations for decentralization have not been taken up, but proposals of inter-basin bulk supply of water supply have been revived. The proposal includes, diverting the Melamchi River, a

tributary of the Indrawati basin north of Kathmandu. in order to augment water supply of the valley.

24 Bringing Tibetans to the area was deliberate, according to the ex Pradhan Pancha of lorpati VDC who said, "*I tried to bring institutional establishments, important people, factories, etc. to make this place important. I also settled the Tibetan refugees here.*"

25 Allowing industries **free connections from the transmission** mains have affected the supply to the city area by reducing the flow. A5 it is an unsound practice in drinking water supply operations, tapping into transmission mains is not recommended in the management of utilities. Only one connection per premise is allowed these days.

26 It is difficult estimate the number of factories as the are scattered. Due to slump in the market, carpet making activities are in recession.

27 Personal communication with Mani Ram Chalise.

28 Effluent discharged from one factory damaged crops for two years in a row.

29 Personal communication with the chairman of lorpati VDC.

30 Compensation for farmers whose crops were affected by effluent from the carpet factory was negotiated by the Chahari Yuba Club. Twenty percent of the settled amount was contributed to the club **to** build its premises.

31 An example of such conflict is seen at Pharping in southern Kathmandu during the dry season. The NWSC has had to guarantee a minimum supply of water **to** farmers **to** transplant rice. Farmers at Pharping claim prior use of the water sources that long precedes promulgation of the Water Resources Act although this claim contradicts priority accorded to drinking water in the Act. The Nepal Water Supply Corporation issues public notices in national dailies asking urban consumers in certain sections of the supply region to cope with the reduced water supply during the period.

32 In legal parlance, it is implied that as new acts are enacted, the provisions made in the *Mulki Ain* will be repealed (Pradhan **1993)**

33 INFRAS **1993**

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