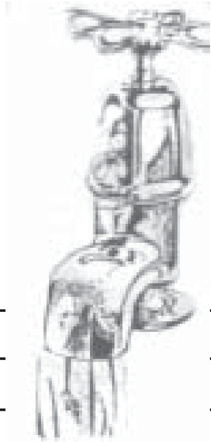
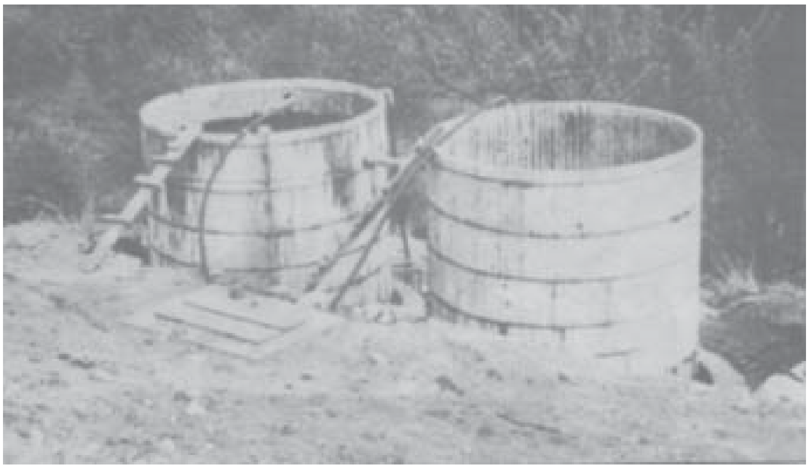
WATER NEPAL



Vol. 2 No. 4, August, 1991

WATER DEVELOPMENT BULLETIN



Pine Wood Water Tanks at Jumla

IN THIS ISSUE

WATER
NEPAL

Editor
AJAYA DIXIT

Water Nepal is published once in three months in English by Nepal Water Conservation Foundation.
Water Nepal aims to function as a forum for sharing of experiences among technologists, engineers, and scientists engaged in different aspects of water resource development in Nepal. It is distributed among the institutions and individuals that are involved in development and management of water resources.
Views expressed in this publication are that of the writers and do not reflect the opinions of the editor or supporters of this publication. Contributions on various issues of development of water resources and its management in Nepal are invited. Typed articles not exceeding 1500 words should be sent to the editor. Unpublished articles will not be returned. Readers are also requested to contribute discussion papers on published articles. The final decision to publish any articles will lie on the editor.

A DROP NOT WASTED IS A DROP SAVED WATER IS LIFT, CONSERVE WATER

EDITORIAL

Breaking Impasse in Water Resource Negotiation

Since its inception as a modern nation state, Nepal has concluded various bilateral agreements with her neighboUrs. Notables among these were the agreements on the Kosi and the Gandaki rivers. The national feeling is that of losing in the bargaining with the more informed and powerful neighbour, because both the agreements did not bring to the country as much benefits as could have been obtained.

These experiences are sources of learning and can have both positive and negative influence in present decision making. A positive approach would be to learn from the experience and improve decisions in the future. The negative influence would be perpetuating the grievances and planning revenge against the opponent. The second approach is unlikely to protect national interests.

A nation's interest is synonymous with the welfare of its people. This is determined by the available resources, and their uses. Water flowing from the Himalaya probably is the only promising natural resources available to Nepal, that can be used for several beneficial purposes. When the resource is abundantly available as in Nepal, it should be traded to generate wealth. Water however, is an unique resource; it is perennial, becomes a part of human life and has sentimental value, unlike other resources, it it does not go, once consumed.

Water can not be traded as other commodities, and its exchange is less likely to be governed by market rules. When flowing water is transformed to other forms, its marketability increases. Electrical energy can fetch better price than water volumes. Goods manufactured using the energy thus produced will have still higher value, as they are open to more wider external markets.

Industrial development remains the key to generate wealth through use of the water resource in its transformed form. Industrialisation however, is determined by availability of raw materials and capital. Nepal will have to rely on selling the abundant hydro-energy until the country's infrastructure is improved to a level where it can transform energy into industrial products.

When trading water in its natural form, bartering often becomes necessary. In bartering, subjective judgements are likely to dominate the decisions. Nepal's agreements with India on Kosi and Gandaki were influenced more by judgements as the country at that time by itself was not in a position to transform water resource into industrial products and demand a market price. The negotiated price had to be determined by the prevailing needs and beliefs of the decision-makers. Since, individual beliefs are always value loaded, they are questionable. Therefore, the price negotiated in the Kosi and Gandaki agreements were disputed.

Bartering is exchanging goods. In negotiation terms, it is establishing linkages between various needs of the parties involved. Bartering however, has no rules and the price of the bartered good can differ significantly when judged from market rules. The system works and parties exchange goods because they feel that their needs are fulfilled with the value they attach to the goods exchanged. An observer can always question the wisdom behind the exchange and even raise doubts about the fairness of the deal. Yet, exchange is wise and fair as long as the parties find it so. A nation must therefore, consciously decide the price it wants to attach to its natural resources to be bartered. Obviously, such decisions are governed by national needs in the particular period.

Modern Nepal's needs are clear; growth in its national wealth for the welfare of its people in a relatively short time. The constraints that impede growth are also known. Physical isolation has affected the country's infrastructure and social development to the extent to defer both national and international investments. Inability to secure a safe and assured access to external markets has further added to the constraints. The 1989 trade and transit impasse with India amply demonstrated how Nepal would be disadvantaged without transit rights. Nevertheless, the needs for industrial development as well as trading opportunities with other countries remain fundamental to the welfare of Nepal.

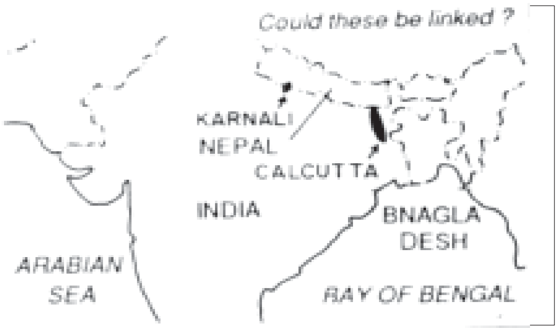
It is therefore, imperative for the country to prioritise interests and be prepared to barter its water resource as a means of increasing wealth. The national psyche must be educated to overcome hangovers of past judgements. Nepal's real needs must guide future negotiations. In such dealings, the strength of the bargaining can be enhanced by the use of information and establishing linkages.

India is an energy deficient country and would continue to be so in the foreseeable future. The country is restructuring its economy. Without meeting the energy needs, it can not industrialise. Its decision-makers hence, will have to find ways to meet the energy needs of the regions that have industrial potentials. Some regions with such potentials border Nepal.

Nepal has the resource to meet part of the growing Indian energy needs. An ingenuous approach would be to find out each other's real interests and be prepared to make tradeoffs. For example, guarantee of secured supply of electricity at cheap cost, to its consumers is the main interest of India. Nepal's interests have always been assured access to external markets and port facilities in India for trading opportunities.

These interests could be linked. The Karnali Project site and the strip of land for connecting transmission line to its national grid could be leased to India for a period of time. In exchange, Nepal could be leased port facilities and a strip of land in India as access to external market for the same period of time. For many, the deal might look unwise and unfair, but the two nations will find such linkages a functional way to open up a new era of co-operation and break the poverty cycle in the regions.

JAGDISH C. POKHAREL



HYDROPOWER SYSTEM DESIGN UNDER MULIPLE CRITERIA – A CASE STUDY OF THE KARNALI RIVER BASIN

Dinesh L. Shrestha and Guna N. Paudyal

(*Hydropower is the preferred energy choice in many developing countries where large-scale projects are planned to meet the growing energy needs. Large-scale hydropower development leads to environmental disruptions and causes social impacts. In such circumstance, efforts should be made to search for alternative development option with least adverse impacts. In the case of Nepal's Karnali River Basin, examination of projects made of smaller reservoirs vis-a-vis the Chisapani High-dam Project is worthwhile. This paper illustrates the concept of an balanced approach by comparing development of a large dam reservoir with combination of smaller system.* –Editor)

INTRODUCTION

The strategy of many developing nations of achieving higher social and economical growth has been upset by the absence of reliable and cheap energy sources. Though, these countries are endowed with resources such as coal, oil, gas, and perennial rivers, they have not been fully utilised. Continued upsurges in the price of fossil fuels and its gradual depletion have caused energy crisis in many countries.

Hydropower can meet bulk power in many developing countries where, fortunately, its large quantum is still unharnessed.[1] Though an attractive source of energy, hydropower development may bring environmental disruption. In addition to economic criteria, impacts caused by waterpower development hence need careful examinations. In some situations, adverse environmental and social impacts outweigh the expected economic benefits.

Without an assured supply of energy, developing countries can not be more productive. Lack of development and poverty as a result become more dangerous causes of environmental stress than development itself.[2] A mid-course approach that provides the energy required for development without environmental disruptions is needed. This can be achieved by formulating a large number of alternative energy development plans, and then select the alternative with least adverse impacts.

Impact assessment is generally based on limited data and biased studies. Polemics and media sensationalism have added new dimensions and in the process incited public opinion about disastrous projects in the making. Efforts need to be made to assess all possible impacts and formulate judicious mitigation plans.

PROBLEM CHARACTERSTIC AND CASE STUDY DESCRIPTION

A dam-reservoir hydropower generation system represents an unique interaction of nature, human society, economics and technology. The planning and design of a hydropower system is, therefore, a complex process involving a great deal of uncertainties. Some of the uncertainties associated with the natural events such as rainfall, inflow of water and sediment into the reservoir can be handled with reasonable satisfaction by means of available probabilistic techniques. But it is difficult to foresee the future needs of the society and technological advancements. The difficulties are further exacerbated by imprecise environmental data and limited understanding of the social context. An integrated and interdisciplinary approach that links a set of input information to the output, as shown in Fig 1, is required.

The concept of balanced development is analysed by taking the Karnali River Basin as a case study. Karnali is Nepal's largest river and drains 43,679 sq. km area in the western region, Fig.2. Three major snows fed rivers of the basin; the Bheri, the Karnali, and the Seti have a combined average annual flow of 43,813 MCM. As the basin's area extends from the Siwalik in the south to the northern Himalayan region, its climate is influenced

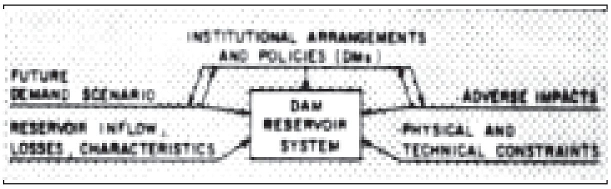


Figure 1: Input Requirements for Dam Reservoir System

by elevation differences within the monsoon regime. About 72 per cent of the basin's annual rainfall is contributed by the monsoon.

Several medium and large-scale hydropower projects have been identified in this basin whose longitudinal profiles are shown in Figure 3. The projects are envisaged mainly to export firm power to the Northern Power Region of India (NPRI) which in the past, has been facing energy shortages. As the plans proposed for developing new hydropower projects including other power sources are not sufficient to meet the growing energy demands, the prevailing situation is expected to continue in the future.[3] Apart from supplying energy, these projects also have the potentials of meeting down stream irrigation requirements while other benefits have been estimated to be marginal.

Individual Potential Capacities

In order to derive preliminary estimates of potential firm energy capacities of the hydropower units of the basin, Dynamic Programming (DP) based on optimisation tool known as State Increment Dynamic Programming (IDP) [4] has been utilised. IDP is a deterministic technique that relies on the historical stream flow data whose detailed methodology is discussed elsewhere.[5] Each hydropower unit is analysed independently with the objective of maximising monthly firm energy that would be generated by each unit. The results are compiled in Table 1.

Figure 2: Karnali River Basin

ALTERNATIVE CONFIGURATIONS

Big Vs Small

There are altogether six reservoir systems deemed feasible in the Karnali Basin where feasibility study of the Chisapani project has been completed.[6] The 270 m high dam, when completed, will be the third largest in the world, largest in the sub-continent and will create a man made lake having a storage of $28x10^9$ m^3. Though, found attractive due to economy of scale, the decision to take up the large-scale project should not be based only on economic criteria.

In many cases, environmental and social impacts become critical, and if little attention is given to these factors, the project

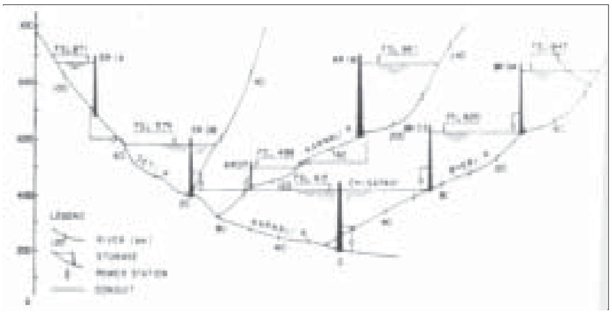


Figure 3: Longitudinal Profile

cost in bound to be extremely high.[7] Detailed environmental and social impact analysis of the proposed project need to be carried out. It is logical to extend the study and evaluate alternative projects. In the case of the Karnali basin, this approach is feasible, as several alternatives have been identified. Smaller reservoirs in the less fragile and environmentally less sensitive region of the basin may prove to be better alternatives, then the large-scale Chisapani project.

Basis for Generating Alternatives

In order to set up alternative configurations from the combination of smaller reservoirs in the basin, in addition to the Chisapani option, some logical and practical assumptions are necessary to avoid large number of possible alternatives. The fundamental

Table 1
Potential Capacities of Individual Project

Project		Firm Energy MWc	Average Energy MWc	Firm Capacity MW
1.	Chisapani	1687.3	2375.2	6749.0
2.	KRIB	1015.5	1414.0	4062.0
	KR07*	330.1	421.7	1320.0
3.	BR03	565.5	649.3	2262.0
4.	BR04	463.7	573.1	1855.0
5.	SR01	162.2	339.2	649.0
6.	SR06	199.8	425.7	799.0

* KRO7 is run-of-river plant located downstream of KR1B

basis is to outline alternative configurations such that each has its capital cost as close as possible to that of the Chisapani project. This assumption is justified for two reasons. First, potential investors have already indicated their willingness to develop the project. Secondly, the emphasis is to seek alternative system that could be developed with almost the same level of investment, but with lesser negative impacts.

As the Chisapani project is studied up to feasibility study stage, at least 10 per cent deviation in the investment cost can be expected. Since, other projects have not been studied to this level, more deviation in the cost – between 15 to 20 per cent - can be expected. Alternative projects whose cost range within ± 20 per cent of the present estimated cost should be listed for further investigations. The cost of hydropower projects primarily meant for peaking operations, are also significantly influenced by the targeted firm capacity factor. In the present study, for all projects the firm capacity factor is assumed to be 25 per cent.

Some possible alternative configurations of the smaller reservoirs are listed in Table 2. The list however, provides only the preliminary set of alternative configurations. Only after calculating the joint firm energy potential of all alternatives and determining their capital cost, can the list be finalised.

In addition to the configurations listed above, more alternatives can be investigated by varying (raising) the minimum operating levels of each unit of the configurations. When the draw-down is small, lesser would be the adverse impacts caused by reservoir bank erosion, visual 'pollution' of the banks during draw-down and less downstream water quality degradations. These gains however, would be achieved at the cost of losing some firm energy, as the operating levels are lowered.

POSSIBLE ADVERSE EFFECTS

Depending on the location and scale of development, the nature and extent of environment and human impacts due to hydropower projects vary widely ranging from being severe to trivial.[8] Identification and evaluation of the possible adverse impacts that would be caused by the planned projects in the basin are done in the following sections. Alternative configurations are compared considering only those impacts that might yield significant differences among he identified alternatives. Impacts of lesser magnitude and those similar in nature and extent are not discussed.

Table 2
Alternative Configuration of Small reservoirs

No.	Combination	No.	Combination
1.	KRIB + KR07+BR04	6.	KRIB + KR07+BR04+SR06
2.	KRIB + KR07+BR03	7.	KRIB + KR07+BR03+SR01
3.	KRIB + KR07+BR01	8.	KRIB + KR07+BR03+SR06
4.	KRIB + KR07+BR06	9.	KRIB + KR07+BR01+SR06
5.	KRIB + KR07+BR04+SR01	10.	BR03+BR04+SR01+SR06

Reservoir Bank Erosion and Potential Landslides

In the Karnali Basin, the planned projects are located basically in two physiographic regions; the Siwaliks and the Middle Mountains. The Siwalik is constituted to weak and redouble sedimentary rocks, which is more susceptible to sliding and erosion. Presence of bedding planes and joint failure compound instability in the region. On the other hand, the middle mountain region is constituted of moderately metamorphosed sedimentary rocks, which are more stable and stronger. The smoother and uniform landscape of the mountainous region is characterised by several river dissected narrow and steep valleys. Compared to the Siwaliks, this region also receives lesser rainfall.

Given the different physiographical characteristics, it is natural that the extent and magnitude of the adverse impacts induced by the reservoirs would be different in the two regions. Bank erosion and induced landslides would be more severe in the case of a reservoir located largely in the Siwalik formation than in the upper regions. Such impacts can be measured by establishing functional relationships between draw-down depth, steepness of the reservoir banks and fragility of the region.

Seepage Loss

Another factor affecting the development of the dam reservoir systems in the basin is deep seepage (Leakage) from the reservoir. Significant seepage can be expected in the Chisapani reservoir region,[9] though a latest study insists on insignificant loss.[10] Considering the huge storage volume (28000 MCM), the pressure due to more than 200 m of head and the region's geology, higher seepage loss from the reservoir appears probable.

Inundation of Forest and Cultivated Lands

The loss of revenue based on the market value of timber alone is not the rational assessment of the adverse impacts caused by inundation of forest. Several other intangibles, such as soil conservation, water replenishment, climate stabilisation, air purification and wildlife shelter that would be lost, need to be included. Ecological effects due to the loss of the tree species, and life systems of the area by the inundation also need stringent considerations.

In the Karnali Basin, the more productive cultivated lands are located in the lower valleys and foothills, while the higher reaches are characterised rain-fed agriculture. Although, the agriculture produces are locally consumed, the food balance of the region will be affected once the land is inundated. It would also displace the livestock population, as grasing lands would get submerged. The resulting secondary impacts would manifest in the form of increased pressure on the nearby hills, and destruction of forest in the planned rehabilitation zones. A balanced approach must attempt flooding of minimum forest and cultivated lands.

Areas under different land use categories likely to be flooded by all the proposed reservoirs under the respective full-supply levels, are computed by composing the topographic and land-use maps using the GIS (Geographic Information System) module of ERDAS computer package. The area categories are summarised in Table 3

Social Impacts

One of the major consequences of reservoir development is the displacement of the population from the areas of impoundment. When people get displaced, and are settled elsewhere, it is almost impossible to replicate at any cost, the original structure of the society, socio-cultural values including the individual and social needs at the newly founded habitation. The planned reservoirs will not submerge any city or important population centres but is expected to displace some sixty thousand population.[11] Efforts, therefore, must be made to minimise the inevitable psychological and socio-cultural stresses caused by the displacement, through comprehensive rehabilitation on the displaced population.

Impact on Wildlife

The impact on wildlife due to the proposed configurations would be different. However, the effects of the Chisapani project, on the Royal Bardiya Wildlife Reserve, which is located down stream of the dam, demands careful evaluation. Lower reaches of the Karnali River is the natural habitat of important aquatic species like the Gharials, Crocodiles and the Gangetic Dolphins. Impoundment behind the Chisapani Dam will not only disturb spawning grounds of the aquatic species, but also eliminate some section of their habitat. Another concern in term of wildlife conservation is the project's long construction period. As the project area is located adjacent to the sanctuary, it is likely to be encroached during the estimated 10 years long construction period. Possibilities of illegal hunting and harvesting by the large work force can not be overruled.[12]

MULTI-CRITERIA DECISION-MAKING FRAMEWORK

The objective and the outlined problems constitute a set of discrete alternative hydropower configurations. Out of this, the best configuration has to be selected based on prudent environmental and social considerations in addition to the economic criteria. The problem should be therefore, solved in a multi-criteria decision-making framework for which the avenue is a decision matrix containing scores for each criteria of alternative development plans. In the present analysis, following five criteria have been considered.

(a) Capital Construction Cost
(b) Firm Energy Capability
(c) Irrigation Water Release
(d) Adverse Environmental Impact and
(e) Social Impacts

Once the criteria scores for the alternatives are obtained,

Table 3
Different Land Use Categories that would be Flooded by Planned reservoirs (up to FSL, km^2)

	Descriptin	CHISAPANI	BRO3	BRO4	KR1b	SRO1	SRO6
1	Forest Lands crown density						
	10% - 40%	5.095	4.476	10.128	4.109	0.160	4.956
	40% - 70%	99.962	26.932	6.240	19.134	1.666	2.517
	> 70%	36.905	54.524	1.986	0.274	0.000	1.106
2	Protection Forest	110.276	5.134	17.453	19.114	4.998	9.625
3	Sgrub Vegetation	0.000	2.018	11.840	0.773	2.103	1.948
4	Valley Floor and Footslope	73.680	76.241	26.120	0.002	5.797	15.382
5	Level and Sloping Terrace Cultivation						
	light	1.054	0.122	2.048	4.774	0.242	1.582
	medium	0.000	1.237	9.293	4.297	0.184	0.551
	intense	0.513	0.420	6.914	4.405	0.041	0.013
6	Grazing Lands	3.848	6.264	7.822	3.480	0.058	3.453

an appropriate technique capable of handling multiple criteria such as the one based on outranking relationship e.g. Promethee (I-III), Ekectre (I-IV) and AHP and distance based type compromise solution (LP-metric) can be applied. However, there are no straight forward rules leading to the choice of a better technique. Different techniques may yield slightly different solutions. It is always better to use at least two or three techniques before a final decision on the best alternative is reached. In order to recognise inherent imprecision in the available information and in the decision-making process, fuzzy mathematics may be also incorporated in those techniques to obtain a realistic solution.[13]

DISCUSSIONS AND CONCLUSION

This study has attempted to illustrate the concept of a balanced strategy for hydropower development in a Nepalese river basin. Although, hydropower development is economically attractive, the needs for sufficient attentions towards all possible adverse impacts due to the project have been emphasised. Such considerations lead to alternative development plans. In the Karmali River Basin, fortunately, this can be accomplished as several smaller reservoirs have been found to be feasible. Thus, rational decisions on the selection of the best alternative can be made.

As a point of caution, it should be mentioned that in the Nepalese context, Chisapani is a highly ambitious project and comprehensive study on all the identified aspects is essential. In addition to the probable adverse impacts, that would be caused by the project discussed above, following factors also need careful consideration while contemplating large-scale water projects in the country.

(i) Lack of Flexibility

Once the construction of a large hydropower project is on line, it is virtually impossible to make major changes in the design without sacrificing significant investment. However, future requirements can vary from the original estimate in the course of the long construction period. If the updated estimate turns out to be less, then it can affect economic viability of the project, whose severity depends on the difference between the original and the updated estimates.

(ii) Lack of Experience

Admittedly, large-scale hydropower projects involve resolution of extremely complex technical, financial, political and water rights sharing issues. Since, Nepal has not yet undertaken large-scale development, a good start, would be to initiate smaller projects and gradually proceed for bigger ones as the confidence builds up.

(iii) High Economic Risk

High capital investments needed for a large project is compensated by high rates of return. But from the standpoint of uncertainties involved in these calculations, even a slight cost overrun and/or over-estimation of the benefits could be deleterious not just to the project but also to the national economy. Also for a developing country, it is difficult to justify heavy investment in a particular sector, when agriculture, education, health and industry also are extremely important.

Present investigations show that for any by planned hydropower project, economic analysis should be supported by comprehensive and careful study of the expected adverse impacts. The often illusive benefits from a large project should not be allowed to overwhelm the decisions. For sustained economic growth, developing countries should choose alternative plans with minimum adverse impacts.

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CONSERVE ELECTRICITY
SAVE MONEY

POTENTIALS OF SHALLOW GROUND WATER AQUIFER IN KATHMANDU VALLEY

G. Krishna Rao and Roshani Karmacharya.

(Use of water contained in deep aquifers below Kathmandu has limitation, due to low recharge and high iron content. Water in some of the aquifers is also steadily declining. Preliminary estimates of shallow ground water –1 to 12 m below ground level - shows that the quantity will be sufficient to meet the projected water deficit and its quality is found to be satisfactory. Small diameter dug wells are relatively cheaper which can be built at household levels to ease the water problem. –Editor)

INTRODUCTION

Kathmandu has limited surface water sources as the valley within which the city is situated is a closed basin. All the streams draining the valley are rain-fed whose short courses rise in the surrounding hills. Groundwater investigation[1] in the valley in the sixties the Geological Survey of India located several potential aquifers. After detailed investigations,[2] deep pumping wells depth ranging from 79 to 376 m – were installed at different locations to augment the city's water supply. In some aquifers however, a steady decline of storage has been observed.[3] Further extraction of water from these aquifers without recharge could lead to irreversible and damaging consequences. At certain wells, the quality of water has been found to be low because of high iron content.

With the increase in its population, Kathmandu's water supply is getting inadequate. The hardship is expected to continue as the water defecit, by the year 2001 A.D. is projected to be 43 million m^3/year.[4] To meet this shortfall, plans are underway to divert the Melamchi River from north of the valley. The inter-basin transfer would necessitate a 27 km long tunnel through the fractured gneissic rocks of the Sheopuri ranges at a very high cost. It is, therefore, logical to seek alternative ways to meet the demand at lesser cost. Shallow aquifers in the valley have the prospects of meeting the water needs from both quantity and quality considerations.

PHYSICAL SETTING

Kathmandu valley has a sub-tropical climate with the maximum temperature getting as high as 36 degrees while the minimum gets to –1 degree celsius. The valley receives an annual rainfall of 1540 mm which increases along the north (2986 mm), northeast (2500 mm) and southern (1920 mm) hill ranges. The drainage system consists of several tributaries which converge in a centripetal form to the Bagmati River at the center. In fact, one of the tributaries, the Manohara River which joins from north east, flows as a major river in its upper reaches.

Altitude of the valley floor lies between 1280 m to 1310 m, where terraces appear for about every 10 m rise in elevation. The basin is filled with fluvio-lacustrine sediments of Lukondol formation of Pliocene age composed of weekly consolidated clay silt and sand with lignite layers.[5] Unconformably overlain by the Quaternary (Pleistocene) deposits, the sediments in the south of the valley form more than 5 m thick and slightly more thicker terraces in the central, north and eastern parts.[6]

In the southern regions, such as Pyangaon, Chapagaon and Bodegaon, Quaternary sediment is composed of cobbles and pebbles while Gokarna, Thimi and Patan areas are composed of finer laminated arkosic sand, clay, gravel and peat. Micaceous sand, gravel and pebble deposits occur along river courses forming low terraces above recent flood plains. Along the valley margins, fan deposits consisting of gravel occur. Gradational changes of facies, from coarse materials consisting of gravel and sand along the Sheopurihills, to predominantly clay towards the south is revealed by the drilling data.[7]

Clays and silt form most of the sediment column in the basin with gravel and sand forming only isolated pockets and lenses in the central part. In extreme south, the granular zones are almost absent while in the north the granular sediment alternate with clay layers including the black type.

The basin is surrounded by hill ranges composed of Phulchowki group of rocks (Early to Middle Palaeozoic) and granite gneisses. Chandragiri limestone, Godawari limestone and Chitlang formation consisting of soft weathered slates interbedded with quartsites occupy the western and southern parts. The eastern parts at Bhaktapur and Dhulikhel are underlain by the Tistung formation consisting of meta-sandstones, siltstones and Phyllite.[8]

DEEP AQUIFER WATER

The underlying geological formation of the Kathmandu basin thus directly influences availability of groundwater. As a result of the sediment distributions, the northern and north eastern parts of the valley contain unconfined systems while multi-aquifer confined systems occur in the north eastern and central parts. In the southern part, significant aquifer zones are absent. Also deep aquifers are of limited extent, which occur only as lenses. These aquifers (depth 60 to 305 m) are reported to have discharge in the range of 1 m^3/hr to 159 m^3/hr. (average of different well fields) about mostly less than 50 m^3/hr. In the central part of the valley, low discharge is observed and in some aquifers water levels are falling.

> **GLOBAL WATER FACTS**
>
> | | |
> |---|---|
> | Earth's total water | = 1357 x 10^6 km^3 |
> | Water on Ocean and Seas | = 1332 x 10^6 km^3 |
> | Water on Polar ice caps and Glacier | = 29.00 x 10^6 km^3 |
> | Ground Water | = 8.3 x 10^6 km^3 |
> | Water of lakes, rivers and streams | = 0.120 x 10^6 km^3 |
>
> Water of lakes, rivers and streams are more easily available for human uses. This volume is only 0.010 per cent of earth's total water which makes it precious.

Chemical analysis of the extracted water[9] indicates that northern and central parts of the basin have different recharge sources. High hardness in the central part infers that its recharge occurs from eastern calcareous deposits. The quality of water from these wells also shows high iron content ranging from 1 to 6 mg/l. A detailed study of the sediment distribution reveals that no part of the valley is free from black clay horizons at some depth or the other. These black clays are the source bed for high iron content in the sediment deposits.[10] As a result to get water free of iron from these aquifer appears hardly possible.

SHALLOW GROUNDWATER

Extraction of water from deep aquifers thus has limitation from both quantity as well as quality considerations. Shallow aquifers - depth 1 to 15 m - on the other hand, do not have recharge problems. Shallow groundwater has been used in Kathmandu from historical times. Dug wells and stone spouts have been built on the terraces and city areas for the tapping natural groundwater since the *Licchhavi* and he *Malla* period.[11] With the advent of piped drinking water, these old supply modes have been neglected and abandoned.

A study of litho-longs of tubewells up to 15 m depth in the valley reveals that the general facies variation of the fluviolacustrine sediment mentioned earlier applies to the shallow depth also i.e. coarser sediment on the northern part, mixed sediment consisting of sand, silt and clay in the central part and fine sediment in the south. The variation of depth of shallow groundwater is shown in Figure 1. Water levels are shallow in the central and lower areas while in the terraces the levels are deep. Deepest water levels are generally observed close to the edge of the terrace or the highest ridge. Seasonal water level fluctuations is reported to be 1 to 2 m which at the terraces is likely to be more.[12]

Chemical quality of the shallow groundwater obtained from stone water spouts and the dug well as summarised in Table 1.

The quality is generally satisfactory for domestic uses and even for drinking in some cases. Tests of dug well water from all over Kathmandu valley reveal that shallow groundwater has satisfactory quality.[13] The electric conductivity ranged between 140-835 umhos/cm (TDS 90-534 mg/l) and in few exceptional cases up to 1923 umhos/cm (TDS 1238 mg/1). This water is excepted to have less iron content. Bacteriological test and detailed chemical analysis for pollution particularly in the densely populated area of the city, should however, be conducted. Though, most pathogens get detained in the soil[14] and ultimately get destroyed, quality analysis helps to decide the purpose for which shallow groundwater could be used.

RESOURCE ESTIMATE

Most of the shallow groundwater resources is not tapped and is lost by seepage flow and/or by evapo-transpiration. An approximate estimate of the resource is as follows:

Table 1
Chemical Analysis of Shallow GroundWater

Properties	Stone spout		Dug wells	
	Ppm		Ppm	
	Max	Min	Max	Min
PH	9	8	8.7	7.5
HCO_3	304	34	502	30
CO_3	nil	nil	nil	nil
C1	150	10	310	50
Total Hardness	120	30	130	40

Total valley area	= 647 km^2
Area underlain by clay	= 37 km^2
Area suitable for shallow water	= 610 km^2
Annual water table fluctuation	= 1 to 2 m
Specific yield of aquifer (for silt)	= 6%

Groundwater recharge/ 1 m fluctuation of water table
= Area x Specific yield x Water table fluctuation

$= 610 \times 0.06 \times 1.0$

$= 36.6 \times 10^6 \ m^3/year$

A perennial groundwater recharge from the rainfall is thus obtained to be between 37 to 74 Mm^3/year depending on the water table fluctuations. This water can be used through dug wells for various purposes in the city sections where hydrogeological situation is favorable. The aquifer yield may also be increased by lowering the water table in the low lying areas where it is close to the ground surface as the valley receives abundant rainfall. Major share of the water use in the valley takes the form of washing, sanitary flushing and use in the gardens. For this use, shallow water would be suitable while for drinking purposes, treated water may be used. In certain parts, groundwater may also be used for drinking but more careful assessment of the quality needs to be made.

Figure 1: Shallow Ground Water Table

CONCLUSION

Shallow aquifers in Kathmandu valley have the potentials to meet the projected water supply deficit. While deep aquifers have problems ranging from limited recharge to poor quality due to high iron content, shallow aquifers water are free from such problems. Water contained in these aquifers can be extracted though small diameter dug wells. Although the quality of the groundwater is good, generally, detailed monitoring is essential to ascertain the extent of the pollution from different sources. Fired clay rings would enable construction of dug wells at relatively cheap cost. Also investigations of the valley's river beds for their base flow need to be carried out and if adequate, collector wells or infiltration galleries could be used.

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PHIKAL MATTERS

Joy Morgan

"I don't want women's involvement in water and sanitation projects just because I like them, but because otherwise the projects don't work."[1] This quote illustrates the change of thinking towards full community participation in the water supply and sanitation sector.

Nepal, the Himalayan Kingdom; however romantic that may sound in a brochure, tourists soon find that walking up and down steep mountain sides with a heavy load is hard work, particularly when debilitated by those stomach upset referred to as 'Kathmandu Quickstep'. Diseases relating to poor sanitation do not restrict them selves to tourists, they affect the health and nutritional status of the whole community in Nepal and make up a high proportion of the 100-150 infant deaths per 1000 live berths. The most important water and sanitation related diseases are diarrhea diseases, parasitic worm infestations, infections of the skin, scalp and eye. Factors contributing to these diseases and their effect on child health are many, but the most significant are the availability and quality of water, practices of personal and home hygiene and disposal of human excreta and refuse.

The traditional culture has its own perceptions of the cause and prevention of disease, which do not always correspond to modern scientific concepts. Thus, despite a high mortality and morbidity rate for the whole population there is little motivation to change hygiene practices.

In order to improve the availability of water, many improved drinking water supplies have been provided over the last twenty years by UNICEF in co-operation with His Majesty's Government. This intervention alone did not bring about any improvements. Combination of water supply construction along with a strong sanitation education component was then considered to be essential. Sanitation promotion through the male water supply technicians was introduced in 1981. This also met with limited success, the reasons being linked with a shy tradition bound culture; water supply technicians are almost exclusively male, giving them limited access with women in an educative capacity. Women, however, are the main beneficiaries of water supply and sanitation programmes, being the water carriers, the caretakers of the family health and the teachers of hygiene practices. A more effective way to reach women is through other women trained specifically for sanitation promotion and improving water system maintenance. Five pilot studies have been initiated in different districts of Nepal since 1985.

Non-directive questioning with the aid of Posters

The Ilam team comprising of two pairs of female sanitation field workers with a co-ordinator, started work in 1989. Each pair of women workers live and work in an area where gravity fed water supply systems are being constructed. (usually 20 public tap stands can be covered in one year).

The work commences with a general introduction to the community; firstly to the politically important members who together organise the screening of a film called 'Water Means life'. Transportation of the generator and projector to rural area for a film show is hard work. However, as many of the villagers may never seen moving pictures before a huge crowd of men, women and children is guaranteed. Despite the English narrative and the African people shown in the film, after the second showing the audience is usually quiet enough to listen to the staff talk over the narrative in the local language. After the show, the entire village talks about the film, if not the water and sanitation messages. On this wave of enthusiasm the staff undertake a survey of the community habits of water and sanitation within the project area, visiting each household to introduce themselves to the individuals and determine the Dynamic Household Score Index (DHIS described later).

The next stage of the project involves the choice of representatives 'Sanitation Volunteer' for each of the tap stands. Meetings are held with the tap stand users at the public tap stand sites. Villagers are asked to choose someone to attend a training on sanitation. Often the men will elect the most politically important, male in the user group but with sensitive questioning about who will use the tap stand and who is responsible for family health and hygiene, the choice of representative is narrowed down to the married female population.

After selection the volunteers are invited to attend a meeting where they appoint at least two members to participate in the water users construction committee, where the baseline situation and the volunteers views and needs on sanitation issues are discussed. A five day sanitation training is scheduled and all volunteers are expected to attend. As each representative is a volunteer it is carefully explained that attendance is not rewarded with money unlike the majority of other tainings in Nepal. However, as the women's time is important a small sanitation kit is awarded at the end of the training. This consists of a tea glass for measuring oral re-hydration solution, a pair of nail clippers, a comb, a toothbrush and a bar of soap.

Puppets discussing maintenance of the New Water System

The trainings must maintain the interest of the participants whilst communicating messages about sanitation or else continued attendance is poor. Subjects which usually need covering include a basic idea about faecal-oral routes and the prevention of related diseases by effective hand washing, safe excreta disposal, the covering of cooked food, safe handing and storage of water, latrine construction with locally available materials, looking after the water source, tap stand caretaking and oral rehydration. Sometimes information on immunisation, smokeless stove building and kitchen gardening are required and included.

Teaching methods which have already been tried out by other workers in Nepal have been incorporated. Often this involves the use of printed or homemade posters and involving the participants with the use of non-directive questioning techniques, which lead them into forming the new opinions required.

If we were to show posters for five days, interest would soon wane, so a variety of techniques is required in the area, small role plays, demonstrations, parodying of popular songs to incorporate sanitation messages, street theater and puppet shows. Messages should remain short and to the point. Each communication technique has its own advantages and disadvantages. Participants can be asked to join the staff during street theater to help an invalid off stage or to clean up a dirty tap stand, whilst puppets can do culturally insensitive things such as a husband showing his wife affection when she recovers from amoebic dysentery or a wife hitting her lazy husband. The reactions to puppet shows have been particularly outstanding. Adults and children alike stand fully absorbed with their mouths open and they remember key phrases for a long time afterwards. Again, if we were to just do a series of puppet shows, interest would decline.

After the training, volunteers are expected to share their new-found knowledge with their fellow tap stand users. This is done informally in their homes with the help of the sanitation field workers. The volunteers are also expected to help them motivate the whole community to participate in the construction of the water supply system, build latrines and incorporate improved sanitary practices into their daily lives.

Monitoring and evaluating such sociological things as sanitary practices needs careful consideration. We could see improvements in habits but these were not highlighted in the usual statistics of the number of latrines constructed. We needed real figures with which to measure the effect of the programme. This led to the development of the DHSI. During the household visits the sanitation field workers observe specific indicators of sanitary habits. Table 1.

Scores in each area should improve over the duration of the programme. Where scores do not improve, new motivation or teaching techniques need to be developed. Using this technique, both staff and volunteers can be instilled with a sense of responsibility for improvement. Providing information is shared, the whole community can become involved. A prize for the household showing the greatest score the greatest improvement on score and volunteer who has effected the most improvement can be awarded at the end of the project.

Median scores at pre-project sites are generally O with maxima of 2 or 3. After completion of projects median scores of 8 are found with maxima of 12 and 13 points. Last year's project site of Pyang village generated 78 per cent of households constructing, using and maintaining simple pit latrines from 0 % at the beginning of the project; cleaning and covering of water storage containers improved from 25 per cent to 61 per cent; knowledge of preparing ORT improved from 15 per cent to 72 per cent. Due to the revolution last April and slow budget release, water projects for this year have not been completed yet but the DHSI point to greater improvements over last year.

Street Theatre emphasising the importance of full immunisation

The presence of faecal coliforms (fc) in drinking water indicates contamination and implies the potential presence of pathogens. The objective is to ensure the absence of faecal coliform organisms from drinking water.[2] This recommendation, however, is considered to be unrealistic and the new recommendation is less than 10 fc/100 ml.[3] It has commonly been reported that initial counts of 0-10 fc/100 ml at tap stands are converted to 10-500 fc/100 ml in households through careless handling and storage. Studies in rural Nepal confirm this trend, where tradition requires that the inside of water containers be rinsed with potentially dirty hands and contaminated soil.

Water testing was carried out in the field at Phikal by ENPHO (a natural resources investigation group) prior to the water supply and sanitation education programme. Householders were questioned about their handling and storage habits as water from their sources and drinking water containers were analysed. Sources with faecal levels ranging from 0 fc /100 ml (protected spring to 2400 fc/100 ml (unprotected spring) produced household drinking water counts of 0 fc/100 ml to 3500 fc/100 ml. The highest of contamination was found at the house of Mrs Durge Kumari Baral. As her drinking water was tested she commented; 'I never clean my storage container with soap because it smells. I always use mud.'

The water tester mentioned to her that mud can be contaminated, but that being sterile and even biocidal, was a better cleansing material. When the test results showed that this household was containing only 2 fc/100 ml, the household was re-sampled. This time she commented; *"I never use soap or mud, I always clean the container with ash"* and the subsequent score was 28 fc/100 ml.

The survey will be repeated next year after the project has been completed. It is hoped that greater improvements will be observed and quantified.

One of the most rewarding experiences must be visiting old sites to find that improved sanitary habits continue to be incorporated by the whole community. Mrs Sancha Maya Thebe of Pyang commented: *"My sons built this latrine for their children and now I find that I prefer to use the latrine than find an undisturbed spot in the cardamon fields."*

His Majesty's Government is preparing to evaluate the success of the women's involvement approaches. The results of the evaluation will be used to determine the future

Table 1

Dynamic Household Score Index

Project Name .... Name of householders ....

Date .... Family size ....

Award positive observations or responses with one point.

1. Do members of the household use one area for defacation?
2. Is this a sanitary latrine? (one where flies are denied access to excreta)
3. Is the latrine slab clean and dry?
4. Is there anal cleansing material available in the latrine
5. Do household members say that they wash their hands with soap or ash after defacation?
6. Do the inside of water containers look clean?
7. Are water storage containers kept covered?
8. Is cooked food kept covered and thoroughly re-heated before consumption?
9. Is domestic rubbish disposed of in a compost pit?
10. Is the tap stand in perfect working order?
11. Are the tap stand surroundings clean and tidy?
12. Is waste-water reused for irrigation?
13. Can a member of the household recite the correct recipe for oral rehydration solution?
14. Can a member of the household name the correct day in the month when immunisations are given at the health post (or more locally)?
15. Do each of the children in the household have a current immunisation record card?
16. Has the household shown interest in sanitation by other initiative? ie table for drying plates.
    clothes lines in the sun
    .showere room.
    smokeless stove

Total points household score index.

sanitation programme in Nepal.

NOTES

[1] Saul Arlosroff of World Bank/UNDP made this comment in a IRC Newsletter.

[2] This is recommended in WHO Guidelines.

[3] Feacham et al.

Improvements of both personal and social hygiene are the most fundamenal criteria for preventing diseases

WATERSHED MANAGEMENT IN HIMALAYAN REGION NEW CHALLENGES

Keshav M. Shakya

(Highlands in the developing countries of Asian and Pacific regions, form home of about 25 per cent of the world's population. Forests, pastures, ranges and marginal lands are gradually being encroached due to the increasing pressure of the population. Inappropriate cultivation practices, removal of forest cover and excessive grasing are rapidly depleting resources bases in several watersheds. Attempts are being made to stall the deterioration, understand the problems and prescribe solutions by watershed management. This paper sums up the experience of watershed management and various factors that influence its execution. Editor)

INTRODUCTION

A watershed is a topographically delineated area defining the drainage system and forming a hydrological unit. It represents the interdependency of land, water and vegetation and hence, forms the logical base for resources use planning and management. The identifiable boundary also gives a sense of finiteness and tangibility.

Past efforts of balanced resources use have provided insight into the ways of managing the natural system and provided useful information. Yet, there is a lack of clarity in the understanding of the problems, caused by conceptual differences about the objectives, suitability to techniques, and implementation procedures.

Some the factors which affect proper management of watersheds are the rationality of approach, objectives, planning methods, social feasibility and institutional capability in executing the programs. A better understanding of the issues is called for to prescribe appropriate solutions.

RATIONALITY OF APPROACH

The first question to be answered is the rationality of the approach itself. Is watershed management a reality or an utopian dream? Views differ, as both the positive and negative aspects of the approach are put forward. Some of the achievements articulate justifications of watershed management, while reservations about the claims are also expressed.

Firewood collection in Jumla

Defense for Watershed Management

Watershed management is generally advocated under the broader scope of soil conservation, extended over the whole watershed to manage land, vegetation and water.[1] The benefits are reduction in downstream sedimentation and flood effects. Water is considered to be the best index of watershed management and if a basin is properly managed for water, then it is also likely to be managed in other ways.

The emerging concept of management incorporates conservation, development and utilisation of soil, water, vegetation and people within the watershed to meet specific objectives.[2] Upstream-downstream links both in bio-physical and socio-economic dimensions to sustain resources use without disturbing ecological balance of the watershed is recognised by the new approach.

Criticism of Watershed Management

Sedimentation and flood control were the stated major advantages of management of watershed. The logic was based on the assumptions that downstream flood was more due to upland activities; particularly deforestation. But flood has continued to ravage and has resulted from even heavily forested areas. This logic that upland vegetation only will prevent major flooding in the plains is over simplification and hence questionable. In incessant rains, even forested areas loose their protective roles when saturated. During a heavy rainstorm, when the 'sponge' is full, all the rainfall input converts into run-off as no buffering effect exists.[3]

Trees have only minor role in reducing flooding from an infrequent major storm event. Peaks in local streams may however, be delayed and flood volume usually reduced by reforestation and vegetation. In the lower plains, watershed management have lesser effects because sedimentation and flooding are more due to geomorphic character of the rivers than human interference in the natural regime.[4]

Usefulness of Watershed Management

Above criticisms however, do not mean that watershed management has no benefits. Each watershed responds differently to physical interventions, yielding response of different magnitude and order. In a major river basin, where mass wasting frequency is high, soil conservation alone will not reduce sediment yields. In smaller and isolated watersheds dominated less by mass wasting, soil conservation does bring improvements. Size of the watershed hence acquires importance.

Usefulness of watershed improvement lies is sustaining productivity on a per unit land basis. The focus on large-scale plantations makes sense, to meet fuel, timber, and other products. As an approach to rehabilitate degraded, unproductive land to produce useful crops, and to gradually rebuild productivity, the role of tree plantation is well proven. But to advocate reforestation for flood containment is something of a myth. Such misunderstanding and misinterpretations have to be cleared by appreciating the relationship between tree cutting, storm flow and downstream flooding.[5] Usefulness of watershed management must be justified in upstream benefits itself.

The downstream benefits of management are greater on smaller watersheds. A watershed of area in the range of 5 to 30 sq km is considered small, which links a big watershed and land. This definition conforms to the rural economy, the development pattern as well as the interest of the farmers. As such, its management can integrate gully control, paralleled with slope protection where activities such as tree plantation, shrub and grass, and engineering measures can be coordinated to control erosion.

Many watershed management projects undertaken in small areas are successful. The Phewatal watershed project in Nepal, with an area of 116 sq km is one such example, which has increased the life of the Phewa Lake. The Begnastal-Rupatal watershed project, in Pokhara has a small area and snows promising results. Small watershed project are found to be successful in China also.[6]

OBJECTIVES

What sould be then the objectives of watershed management for larger areas? Is it management of land to achieve sustenance and an increase in the productivity of watershed? Or s it erosion, sedimentation and flood control?

The objectives are several but imprecise and ambigous. Lack of objective definition does not help in translating them into institutional support. Objective definition however, is essential because it specifies the management approach.

For example, if the objective is to increase water yield of a basin, cutting of the high transpiring vegetation's and conversion to grass land use would be desirable. If the objective is to improve the life of a reservoir, sediment control measures like check dams, landslide control, plantation, terracing, sediment traps etc will have to be adopted. For production increase, activities like contour cultivation, terrace improvements, water management, improved seed and application of adequate fertilisers should be undertaken.

Increased Productivity

Increased productivity is one of the most important objectives of watershed management. When the question is survival[7] and the overall objective is to upgrade the quality of life, the emphasis on production increase makes sense. It would be wise to emphasise the production function of soil conservation programme to help produce more food or more water.

These can be achieved by two ways. One is to include in the soil conservation program/project, production func-

Water politics

Malaysia has abundant water resources but how to manage them has become a political a political issue - at least in West Malaysia. The state of Johor, for instance, has enough water to supply Singapore, while the neighboring state of Malacca actually ran out of water last year - a fiasco which has prompted the Malaysian Government to propose the co-ordination of water supply throughout the country and bring in a new water supply act, reports Water and Sewage published from Hong Kong in its March 1991 issue.

At present each of the 13 states manges its own water supplies and collects the revenues, so some states are not in favour of a centralised water management, fearing they may lose revenue.

The argument for centralisation is that water is a limited resource and needs efficient management to ensure that all states have enough. Also water development programmes are easier to implement if handled but a federal body.

The president of the Board of Engineers, Datuk Wan Abdul Rahman Yaacob, believes that centralising water management would ensure there was body to supervise and counter check water supply in each state. Loss of revenue could be matched by compensation from the federal government.

On the other hand, some believe the states have to control water because so many land matters are involved.

One suggestion is that a federal waterworks department and the science, technology and environment ministry should manage water between them since this would ensure that development did not affect water catchments.

The debate continues.

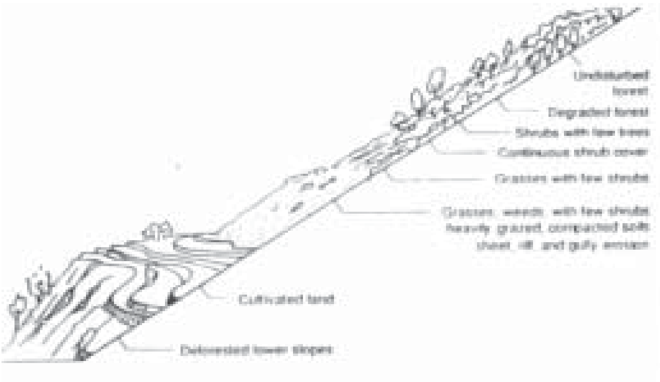
tions such as crop management and minor irrigation. The other is to integrate soil conservation in other activities such as crop expansions, land settlement and rural management. The best strategy would be to emphasise production function and integrate soil conservation practice into the farming system.

Increased production goal can be achieved through the provision of proper crops types, insects and pest control, and marketing. Co-ordination between the institutions with capability to address these issues is important. Soil conservation only cannot increase productivity and therefore, should not be seen as an independent decipline; an end in itself.

Soil erosion should be seen as the consequence of land use, not the cause of soil degradation.[8] Once this is accepted, no separate conservation services would be needed, but only conservation specialist within an extension service. Then, soil conservation should be substituted land husbandry; to be supported by extension and research. Physical control activities can be used when necessary to support biological conservation works. Th loss of productivity should receive stress than soil loss.

Erosion and Sediment Control

Watershed management is also taken as the protection function of soil conservation to reduce sedimentation rates. The nature of



Land degradation near settlements in hills

the sediment problem in the Himalayan region, however, demands an approach, to incorporate mass erosion contribution from both vegetated and unvegetated slopes. While small landslides tend to occur on unvegetated slopes, larger and deeper slides occur independent of vegetation cover. Forest over may not prevent slides if the terrain is inherently unstable. Over a sufficiently long period, the net contribution of sediment might be same.[9]

The logical way out of sediment problem would be to take measures during the project design stages. Reservoirs should have capacity to absorb higher sedimentation. Irrigation canals must be provided with sediment excluder and bypass arrangements while temporary diversion could be used as the headworks. When river discharge and bed load exceed certain level, the diversion may be washed, permitting the flood to move harmlessly. The diversion can be remade after the flood has receded.

WORLD'S WATER DISASTER VICTIMS IN A YEAR

	1960S	1970S
FLOOD	18500000	22400000
DROUGHT	5200000	15400000

Source: International Water Tribunal

Accelerated erosion occurs in the marginal agricultural lands and over grased agricultural fringe areas. These should be the primary targets for soil conservation. Drainage improvements, bio-engineering works slopes and trail improvements with the provision of proved drainage can reduce erosion form these areas.

Multi objectives

Watershed management should therefore, increase productivity without depleting the resources base. Since, one discipline alone will not be able to tackle all the issues, an interdisciplinary action is required. Coordination among sectorial agencies such as forest, agriculture, livestock and water resource becomes important. The single objective approach must be therefore, replaced by one with multiple objectives. Problems of erosion, siltation and flooding as well as productivity increase should be targeted by treating the whole watershed in an integrated manner. The objectives should be environmentally and economically sound, while being socially acceptable.

This concept is enshrined in the Total Catchment Management (TCM) approach.[10] It recognises that natural resources can not be managed in isolation without recognition of the impacts various land uses have on one another as well as on the broader environment. Through a co-ordinated approach, the method recommends uses and management of land, water, vegetation and other natural resources on a catchment scale to maintain the quality and yield of water. To achieve conservation goals the method involves the community through communication, co-ordination, cooperation and considerations.

PLANNING APPROACHES

These objectives need to get translated into action, for which certain tools and methodology would be needed. Both the top down and bottoms up approaches are used in managing the watershed. Both approach have important implications which need further elaborations.

One of the planning tools, is the land capability/suitability classification. This has led bulk of the land in the mountainous regions designated unfit for cultivation. It is a rigid system of land use planning based on the assumptions that users can be persuaded to stick to it. The approach also forces the users to adopt what planners think is right. During implementation the approach becomes unpopular, socially unacceptable and economically undesirable. In reality, millions survive and will continue to depend on rainfed and sloping land. Watershed management plans must be flexible for pragmatic reasons in which strategic provisions must be made for compromises and tradeoff opportunities.

Farmers and the local community must be included in the planning process as important actors. As such plans are sensitive to the problems needs and the constraints, they are realistic the basic problem with watershed management however, is its very definition and the relationship with the social and economic factors. In practice, this inevitably leads to the top down interventions, where the land users get relegated to secondary priorities.

Even in the participatory approaches, the top-down elements such as government policies, existing legislations, institutional capabilities and resources become unavoidable. This demands a methodology to balance between what ideally needs to be done, and the pragmatic approach which accepts continuation of cultivation of sloping land, and as practicable as possible, erosion reduced. A planning approach based on physical constraints, local participation and project capacity[11] can help to achieve the objectives.

IN 1927 A. D. the construction of Nepal`s first scientifically designed irrigation project was initiated. Designed and supervised by two British Engineers deputed by the Government, the project was completed in 5 years at the cost of Rs. 24,00,000.00 IC. Built on Trijuga river, a tributary of the Kosi, it irrigated 14,000 ha. land in Saptari district.

In 1960, Nepal`s rivers were categorised as

(a) Snowfed rivers of the Himalayas which also drain Mahabharata catchments. (Perennial)

(b) Rivers originating in the Mahabharata hills. (Seasonal)

(c) Rivers originating in the Churia range and its southern slopes. (Ephemeral)

Source: Report of Agricultural Conference, 1960, Ministry of Agriculture, HMG, Nepal

These four form separate but interacting elements in an implementation plan. Physical criteria defines the programme ideally needed to fulfill the project objectives. Participation forms the set of objective that reveals the peoples' priority. Project capacity determined by budget constraints, the formal administrative structure, attitude and the capability of the project personnel forms the third set. Optimisation models of land use planning employing interactive iteration using tradeoff information of the multiple objectives of increasing fuel, fodder, and food production at reduced erosion and development cost has been developed for Nepalese hill agro-ecosystem.[12]

The starting point for a national resource management strategy is the base line resources inventory. Computerised compilation of data pertaining to geology, land, soil, meteorology and hydrology using GIS techniques have made traditional methods old fashioned. Not only has storage and data retrieval become faster, integration of different sources of data is also possible now. The range of Rapid Rural Appraisal Techniques (RRA) further allow quicker compilation of the base line data whose collection by the conventional methods would be time consuming.

SOCIAL FEASIBILITY

Is watershed management then socially feasible and does its priority match up with that of the local population? Erosion by volume or weight of soil washed from agricultural land means little to the farmers. A farmer's concern is fertility and what soil can produce for him. Farmers rarely see erosion or other forms of land degradations as priority problems, and is seldom interested in conservation program as it offers no short-term benefit. Soil conservation is seen as additional works and expenditures with the possibilities of risks if the advocated practices are adopted. Where subsistence farmers dominate, emphasis on erosion control only will not ensure their participations.

Problems associated with land emanates from the assumption that farmers act within an environment of constrained rationality. The farmer, who is expected to do much of the work is seen as just one of the factors to be changed or even worse, as the problem to be overcome.[13] This dilemma stems from an inherent conflict between science and art. Science sees the agent (farmer) as a sort of zombie, who just sits, his life altered by the targeted policies, whilst art sees him as the responsive being who may be expected to, not just receive such policies but also to react to them as well.[14]

The practices would be clear, once the limitations within which the farmers act are considered. If prices for agricultural products are depressed, or if there is no access to assistance on conservation practices, it is not surprising to find cute problems of soil degradations. The accepted approach is to address conservation through regulatory policies instead of assisting land users in meeting conservation objectives. Positive attitudes and behavioural changes, as result have not come about leading to ineffective conservation programmes.

INSTITUTIONAL CAPABILITY

What institutional supports are then needed to address the problems? Should management be concentrated on few important watersheds or be carried out on a nation wide scale? From a hydrological perspective, an integrated approach of management is most desirable. Catchment management plans based on this approach has been developed in New South Wales and India, where line agencies managing Forest, Soil Conservation and Agriculture provided services supervised by a coordinating agency. Nepal attempted an integrated approach in the Resource Conservation and Utilisation Project (RCUP) and Tinau Watershed project. In practice however, these initiatives have been affected by resource constraints, legislative draw backs, bureaucratic limitations and lack of co-ordination.

Resource Constraints

Watershed management projects tends to be costly, slow and cumbersome to implement, and because attempt is made to treat all problems, they tend to have low cost benefit ratios. The programmes tend to be discriminatory as only a small portion of the country is dealt at a time incurring high cost and manpower requirements.

Lack of resources in the developing countries do not allow the activities to be taken on a nationwide scale. Concentration of all the manpower and resources on a few watershed however, is not fair to the people of other watersheds, which would also be politically undesirable. Few successful programmes do not stretch resources and manpower too thin, which are cost effective too. A compromise would be to undertake programmes on critical watersheds and provide general services for other areas.

Legislative Drawbacks

Legislative provisions are required to implement watershed management plans, set technical standards to carry the activities from the national to farm level. Most of the introduced legislations identify and recognise the problem but do not ensure that rules are translated into ground action. For example, the 1982 Soil Conservation and Watershed Management Act of Nepal has not been implemented even in a single watershed.

Bureaucratic Limitations

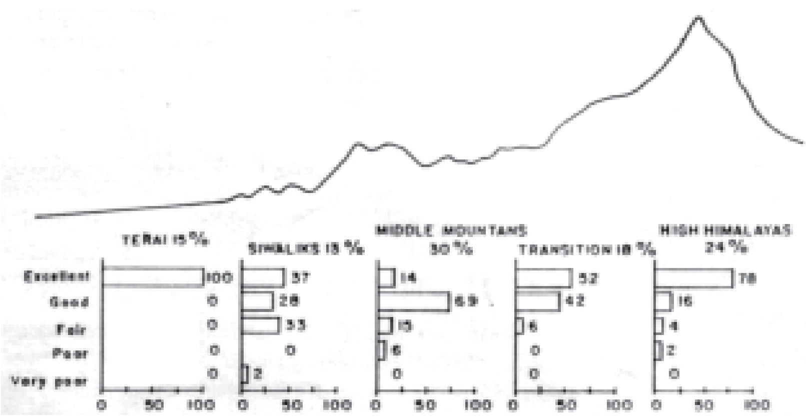
Function of the organisation is the key to the success of watershed management. But agencies that manage natural resources in the developing countries are traditionally patterned which are authoritative, conservation, inflexible, ineffective and inefficient.[14] These attributes lead to an organisational behaviour that is more traditional, cautions and protective. A compatibility between the strategic mission that the organisation has to achieve and its culture is important.

Lack of Co-ordination

Integrated approach of watershed management succeeds only through co-ordination among the line agencies. Coordination however, is not achieved due to departmentalisation that results in internalisation of execution of programmes and policies. This is amply evident in the watershed management projects. Some offer greater political benefits than the other, and are hence, pursued more enthusiastically.

This culture generally identifies the projects of one or two major ministries/department with politically popular elements. As a result, no capital aid content or little top level political support is provided to unsuccessful departments. Thus it results in building an empire, as incentives to other agencies to complete projects on a priority basis are reduced. Many projects then becomes unsuccessful.

Functional duplication is the logical consequence of departmentalisation.[15] Department, that wishes to expand, tends to extend its scope



Watershed Classification by classes in Nepal to attract maximum share of the available resources. It also prevents, competing departments without access to major benefits from the given project, from co-operating and co-ordinating with the implementing department. A situation of more incentives for that department to internalise, and bring all the activities under its own control is thus created.

CONCLUSION

Increasing popularity of watershed management in the region calls for development of sound and long-term national strategies that judiciously incorporates the issues identified above. The challenge is not to choose one approach at the cost of the other, but to usefully combine the two models of understanding. This, in the context of watershed management, is a harmonious blend of science and art. Science has little place for perception, as it deals with technical fixes. Art by contrast, accords a central place to perceptions and anticipates the obstacles that may influence the technical fixes.

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THALWEG AND BANKLINE MOVEMENT BEHAVIOUR OF BRAIDED RIVER: AN ASSESSMENT OF JAMUNA RIVER IN BANGLADESH

M. Zillur Rahman, Subrata Paul and A.K. Azizul Hoq Bhuiya

(*The Brahmaputra - Jamuna is a braided river characterised by a high variation in flow directions, rapid bankline shift. Wider channel width and shallow depth, high rate of thalweg wandering, unstable and mobile chars are the river's other associated features thalweg of the Jamuna is a gateway for navigation, fish migration and source of irrigation during lean season. Understanding of the behaviour of thalweg and bankline movement is important aspects of river mechanics and training. Analysis of maps, cross-sectionals and bathematric charts, and field information revealed that thalweg and bankline are positioned independent of each other. No harmony can be traced in their shifting pattern, which is in contrast to the meandering river whose bankline migration is closely associated with the thalweg movement.* –Editor)

INTRODUCTION

The nature and movement of thalweg (i.e the deepest line or the line of maximum depth of a river channel) is an important aspect of river mechanics and training. Thalweg appears in sinuous form in a straight river, whereas, in a meandering river, it is near the concave bank at the place of maximum curvature opposite to the point bar in the convex bank.[1] Shifting pattern of the thalweg maintains significant correlation with that of the banklines. But, in a braided channel, deposition of sediments in one locality causes deepening scour in another locality. Thalweg thus appears to wonder continuously from one position to another within the river-banks.[2]

Jamuna River

Thawleg of the Jamuna, a typical braided river, is a gateway for navigation, fish migration and source of water for irrigation during lean periods. It is therefore, necessary to understand the rate, magnitude and directional movement trends of thalweg from the banklines of the Jamuna River. This study is an attempt towards that direction.

METHODOLOGY

In order to evaluate the river behaviour; maps, charts and other relevant information were identified. Maps and charts prepared by Bangladesh Water Development Board (BWDB); Jamuna Multipurpose Bridge Authority (JMBA), and Bangladesh Inland Water Transport Authority (BIWTA), were obtained. These were used to measure the parametric attributes of the thalweg and banklines of the river in both the spatial and temporal basis. Cross-sectional charts at 33 locations obtained by echo-sounding methods were collected from BIWTA, BWDB and JMBA. On this data, detailed parametric measurements of the thalweg and banklines movements were made (rate magnitude and direction). The measurements were made (rate magnitude and direction). The measurements were made with reference to a particular point on the bank along each location.

RELATION BETWEEN THALWEG AND BANKLING MIGRATION:

The position of the thalweg and banklines showing locational distances for 1966, 1974 and 1977 with reference to their respective position in 1966 and 1974 are presented in Table 1 and Figure 1 and 2. The changed position is worked-out on the basis of BWDB bankline - thalweg map relative to the right bank. Positive and negative values indicate eastward and westward movement of the thalweg and bankline with respect to each base year and positions. The distance between thalweg and bankline for a particular year along a cross-section is the subtracted values of the corresponding pair.*

* For example, the locations of thalweg and bankline at j# 3 - 1 in 1966 are given by +8.71 and -3.36 km respectively and they are positioned at a distance of [(+8.71) - (-3.36)] = 12.07 km. That is they are positioned 12.0 km apart at a point of time during 1966 along the cross - section j#13 - 1.

Table 1 shows that about 33 per cent of the 97 pairs of thalweg - banklines positions lie within a distance of 1.0 km, whereas, 12.3 per cent are within a distance of 0.5 km. In 1966, thalweg and bankline were positioned 12.07 km apart along the section J # 13-1, which was the largest distance between the two. It is followed by a distance of 10.82 km (1966) and 10.82 (1974) along J# 7-1 and J # 3, respectively. For obvious reasons, the thalwegs are at close proximity of left bankline of the river. The

Table 1
Bankline and Thalweg Displacement of the Jamuna

Cross Section	Thalweg shift (X) Km			Bankline Shift (Y) Km		
	'56-66	'66-74	'74-77	'56-66	'66-74	'74-77
J # 17	+0.85	-1.07	-	+1.74	-1.00	-
J # 16-1	+0.10	-0.21	-	-2.17	+1.22	-
J # 16	+1.53	-0.58	+2.72	0.37	-0.18	+1.00
J # 15-1	-2.53	+4.93	+0.97	-0.15	0.61	+0.98
J # 15	+4.12	-1.13	-3.69	+1.46	-0.27	+0.07
J # 14-1	-1.96	-2.20	+1.83	+1.80	-0.24	-0.43
J # 14	+2.72	+5.95	-1.37	-1.77	-0.82	+1.68
J # 13-1	+8.71	-2.50	+5.19	-3.36	+3.59	+4.05
J # 13	+0.03	-0.21	-1.65	-0.67	-0.61	-0.39
J # 12-1	-0.88	+1.07	-2.02	-0.82	+2.56	0.00
J # 12	-1.62	-3.61	+1.52	+0.67	-1.07	-0.15
J # 11-1	-3.91	+4.86	+0.76	-0.76	+0.30	+0.58
J # 11	-0.24	+0.39	-0.09	-1.07	-5.3	+4.49
J # 10-1	+0.58	-2.29	+5.50	+0.06	0.00	+0.00
J # 10	+9.98	+1.92	0.00	+0.06	0.15	+0.33
J # 9-1	+1.80	-0.39	-0.21	+0.52	-1.16	+0.73
J # 9	+4.31	+0.95	-2.26	-0.27	-0.95	0.00
J # 8-1	-1.41	+2.81	-2.32	-0.55	-0.43	-0.73
J # 8	+0.43	+1.10	-5.75	-1.59	-1.28	0.00
J # 7-1	-11.28	+0.82	+0.89	-0.46	+0.15	+0.61
J # 7	-8.22	0.00	-0.09	+2.08	-0.34	+2.32
J # 6-1	-3.18	-0.25	-1.44	+0.15	+4.12	+4.89
J # 6	-0.82	+3.45	-0.49	+1.48	-0.36	0.00
J # 5-1	-0.92	+0.33	+1.71	-2.05	-1.10	-4.31
J # 5	-4.37	+1.80	+1.77	-1.16	+0.76	+2.21
J # 4-1	-1.00	-2.41	-0.89	-1.71	-0.67	+1.21
J # 4	-5.29	+1.68	+0.67	+0.12	+2.35	+2.84
J # 3-1	-3.97	+1.06	+2.54	+4.22	+0.36	+3.18
J # 3	+8.59	-9.53	-0.76	+3.08	-0.61	+0.76
J # 2-1	-1.31	-0.55	+2.066	-1.46	-0.21	+2.60
J # 2	-3.02	-0.45	+2.93	-1.22	+0.09	-1.19
J # 1-1	+0.12	-7.52	+4.86	+0.39	-0.58	-0.12
J # 1	+0.00	0.00	-4.37	-0.15	-0.03	+0.03
Mean	-0.86	-0.11	+0.62	+0.03	-0.03	+0.92

lower spacing of 0.01 km between bankline and thalweg occurred along J # 15-1 in 1977. This was followed by distances of 0.03 km (1974), 0.07 km (1974) and 0.15 km (1966) along stations J # 1, J # 17 and J # 1, respectively. Almost 50 per cent of total pairs of thalweg - banklines show a migrational trend away from each other, i.e., they move in opposite directions. Over 25 per cent of thalweg – bankline pairs show eastward unidirectional movement, while the rest show westward shift. Whichever is the directional trend, magnitude of migration is non-uniform both along the cross section, and in time.

The findings show that thalweg and bankline are positioned independent of each other. In order to establish the validity of the observations, correlation between the positions (expressed in distance) of thalweg and bankline was evaluated. The calculations are done in two stages; first, the co-efficient of correlation (r) is calculated, which varied from –ve (1) for a perfect negative correlation (inverse relation) to +ve (1) for a perfect positive correlation (direct relation). A zero value indicates no correlation between the variables; and secondly, the significance of the correlation is decided.

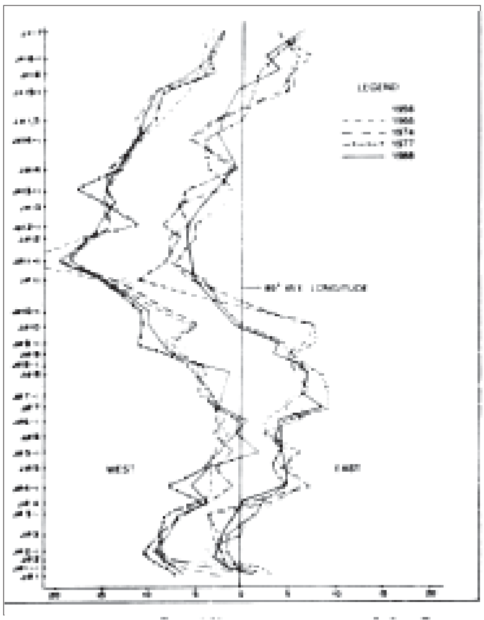

Figure 1: Changing Bankline movement of the Jamuna River

The calculated correlation co-efficient (r) and the co-efficient of determination (r^2) are shown in Table –2. It is clear from the table that correlation coefficient (r) between thalweg and banklines for 1956, 1974, and 1977 range from –0.1308 to 0.0042 implying lmost no correlation between the migration of bankline and thalweg. It is evident that unexplained variables are

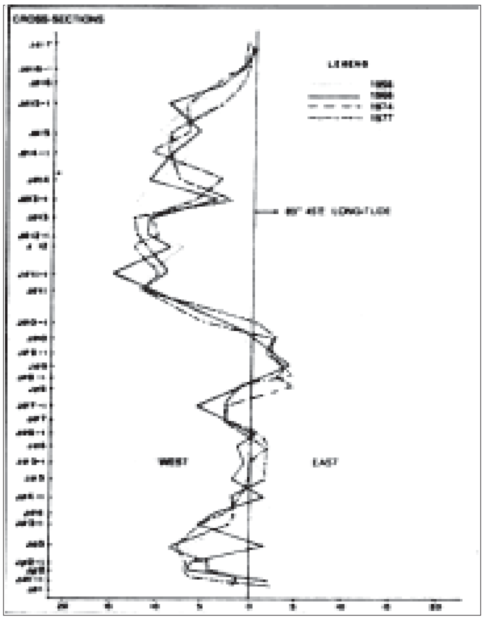

Figure 2: Changing in Thalweg position in the Jamuna River

almost 99 per cent where all the 97 pairs concerning 'X' and 'Y' variables are involved in the calculation of r. This clearly demonstrates that thalweg and bankline are positioned very independent of each other, and no harmony can be traced in their shifting pattern.

Table 2

Correlation between Thalweg (x) and Bankline (y) Displacement of the Jamuna as positioned in 1974

Year	Correlation of Thalweg and Bankline Displacement (r)	Coefficient correlation of determination r^2 r2	$1 - r^2$
1956 to 1966	-0.1308	0.0171	0.9829
1966 to 1974	0.073	0.0054	0.9946
1974 to 1977	0.0042	0.00001	0.9999
All 97 points	0.008	0.000064	0.999936

CONCLUDING REMARKS

The Jamuna is a typically braided river with multiple channels around islands (chars). Chars in the river are transient, and drastically change their shape, size and location.[3] They are the product of the river itself and composed of relatively coarser materials. Since, most chars change their shape, size and location with time, they cause drastic changes in area any cross-sectional and also 'push' the banklines to migrate. The channel as a result is widened.

Spectacular changes in position of the thalweg between 1956 and 1977 are observed. Maximum displacement of 9.3 km in J# 7 occurs in 21 years whose rate of migration is 444.16 m/yr (72.03 per cent). The lowest displacement distance is found in J#9 in which the rate of change is 4.74 m/year with a magnitude in the order of 0.87 per cent. The highest displacement in bankline migration is 9.2 km along cross-section J#11 during a 11 years time span (1966-1977). The rate is 843.04 m/year with a magnitude of 78.78 per cent The lowest migration of the right bank appears in J#3 whose thalweg and bankline are positioned independent of each other, and no harmony can be traced in their shifting pattern. This is in contrast with meandering river in which channel migration is associated with the thalweg shift.

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Char : Temporary island in river channels and in estuarine or coastal areas, formed by sediment deposited under flood which is highly susceptible to destruction under subsequent floods.

USERS ORGANISATION IN IRRIGATION MANAGEMENT

Prachanda Pradhan

(Irrigation management becomes effective when farmers are involved. This paper briefly discusses the Asian experiences and suggests ways to make users' contributions more effective in irrigation management. – Editor)

INTRODUCTION

Users' organisation comes into existence, when the irrigation tasks need to be undertaken by the system's beneficiaries. Usually, functional organisations are found in irrigation systems that are managed by the farmers. In some cases, users come together to organise themselves in the form of a 'company' such as those in Colorado and California. Water User's Association or Water Users Groups organised in the company patterns are found in Taiwan, Korea, Latin America, Portugal and Spain.

SINGLE VS MULTI FUNCTIONAL USER'S ORGANISATION

The critical factor that determines the functioning of a users group in irrigation system is its structure; whether the organisation is multi-functional or has single function. Though rare, on different occasions, attempts have been made to make role of the irrigation user's group multi-functional. Single functional organisations, however, are far more effective. Experience in the Philippines, for example, shows the better performance of an organisation with single function. Multi-functional organisation often incorporates contradictory objectives in its functioning, which causes some members to disassociate themselves or limit their participation in the group activities. Functional perspective therefore, is the most important factor in formation of users group. This also helps to determine the type of membership. Non-farmer members in an organisation usually hinder its smooth functioning.[1]

Farmer organisations that manage irrigation systems may also undertake certain non-water related functions. Activities such as provisions of fertilisers, agriculture credits, output marketing and post harvesting operations are some of these functions. Fertilizers, pest control and chemicals augment the productivity of water. On different occasions, farmers organisation ensures that delivery of fertilisers is timely, and also takes pest control activities. Many times, organisations invest resources to buy sprayers, chemicals and equipment which is then made available to the farmers. In such instances, depending on the strength of the organisation and the degree of complementarily, it would be beneficial, or even necessary for the users group to increase the agricultural productivity unit water. This tendency is presently observed in the Philippines.

SIZE LIMIT

Experience of irrigation organisations in farmer managed systems indicate that there is no particular limit, either in the number of the members of the association or size of the area commanded by the system. Functional organisations are found both in a small system with command area in the range of 20-50 ha as well as larger systems irrigating between 3000 to 15000 ha. In the later case, the organisation will have several tiers with specific responsibilities to perform irrigation activities or a federation of the users organisations is formed. The 15000 ha Karnali irrigation system in west Nepal is one such example. However, it would be more effective to build upon smaller groups of about 10 to 15 farmers based on hydrological units at the lowest level for active participation, improved group interactions and reduced conflicts.[2]

EVOLUTIONARY TREND OF ORGANISATION

Most of the functional users organisations generally, have a long history. This dynamics of growth is important to understand and to adopt into the changing social context, an existing users organisation. Their understanding including adaptation by the existing organisation is very important while forming a new users group.

EFFECTIVE ROLE OF FARMERS

Experience of the countries like Nepal, the Philippines, Sri Lanka and Northern Pakistan (AKRSP) demonstrate that the farmers can play effective role in management of the construction, and system operation and maintenance including water management aspects. Farmers have been found to be effective as the members of the project's Board of Directors'. In order to make contribution of the farmers in project development effective, following factors are prerequisites.

Farmer's Participation

The foremost crucial element is to instill the feeling among the farmers that the effort is to help construct or rehabilitate their irrigation system. Project preparation and implementation activities should be channeled through the farmers and focus must be to assist then build their system with the agency functioning as a facilitator. Farmer's participation is necessary at the feasibility study, design, estimates preparations and during the project implementation stages. Transparencies of expenditure, flexibility of accounting and auditing systems are prerequisites to make farmers effective participants in the development activities.

Establishment of User's Organisation

All the beneficiaries in the command area must be included in the organisation. An executive committee should be answerable to the general assembly of the system's beneficiaries which during its meeting reviews the performance of the executive committee, audits the expenditure and evaluates the utility of the rules in general. Such arrangements make the executive committee more accountable to the general body, when its activities also become transparent. Representatives elected by the general assembly of the farmers are far more effective, who can also actively serve in the Board of Governors than hand picked representatives.

Strengthening of User's Organisation

In case of an existing loosely organised users group, efforts are needed to strengthen the organisation. When assisting a farmer managed irrigation system, substantial efforts are needed, if the organisation is not in a good shape. Usually physical target achievements get priority over farmers' capacity development. When strengthening of the farmers' capability is ignored, deterioration of a completed system commences after the construction, because operation and maintenance receive no attentions. Standard of operation and maintenance ate related with the farmers strong organizational capability. Farmer to farmer training program and consultations can be considered for strengthening farmers capacity.[3]

Between 1985 and 89, Services fees collected and the operation and maintenance expenditure in Irrigation Systems of Nepal were as follows :

Year	Gross Rs. Collection ($x\ 10^6$)	O and M Fund Disbursed ($x\ 10^6$)	% of O and M
1985-86	0.5	30	1.6
1986-87	0.6	32.1	1.8
1987-88	3.1	41.5	7.4
1988-89	3.5	51.6	6.8

Source: Gautam, U. P. Subedi R and Gautam, K. M. 1990 Cost recovery inNepal Irrigation, Irrigation Sector Support Project/NEP/89/006

Balance Between Physical and Non Physical Aspects

Both the physical and the non-physical components of the irrigation system are important for its proper management. Physical targets are more tangible, easily measurable, which also take larger share of the expenditure. In many cases, therefore, physical aspects tend to get more prominence in irrigation project implementations. The unsatisfactory results of many completed projects suggest that efforts to strengthen the non physical elements of the irrigation development should begin well before improvements of physical components are initiated.

Government agencies involved in irrigation development are bound by the physical targets and as such more interested in meeting them. Farmers also like to see that physical construction get under way as soon as possible. The experience of the action research project in Sindhupalchowk district of Nepal suggests that once farmers are organised, it does not take long to complete the construction.[4] Although difficult, this approach should be forcefully implemented at the outset of the project with active participation of both farmers and the implementing agency. If farmers are not involved from the beginning, the long-term objective of attaining sustained food production will not be met.

Incentive for Participation

The extent of participation depends on the level of contribution farmers have to make in the construction of a new system or rehabilitating an existing one. Time and flexibility are required to usher in meaningful farmer's participation, who should be intensively supervised. The extent of participation is also determined by the method of construction. In projects undertaken by contractors, participation usually declines because farmers do not have the opportunities of playing active roles during the construction phase. Their confidence, and hence participation will be increased, if accounts are open for public inspection.

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EXCLUDING SILT FROM IRRIGATION SCHEMES

Sediment, a bane of irrigation schemes all over the world commonly causes a 50% loss of canal conveyance capacity. Designers generally underestimate the problem and a large proportion of the operating and maintenance costs is incurred in desilting structures and canals.

HR Wallingford's Overseas Development Unit knows of irrigation projects where the sedimentation rate is five or six times worse that the designers anticipated. To reduce or even eliminate sedimentation HR has carried out extensive research into the design of structure to trap or divert the sediment before it reaches the canals.

Before decisions on the design of intake structures are made, it is necessary to know the range of particle sizes of the sediment. It is obviously more difficult to achieve high sediment exclusion rates when the particles are very fine. On the other hand large particles can be prevented from entering the canal system by a well - designed intake. Water near the surface of a river carries less sediment than water close to the river bed and intakes which abstract water from the surface are a common form of sediment control.


Sediment removal in Sunsari-Morang Canal, Nepal

The most recent work involves development of a numerical model which permits the engineer to describe a detail the complexities of a river reach near an irrigation intake. This allows a realistic simulation of how well a proposed weir, settling zone of sediment excluder would cope with teh sediment. Ed Atkinson, who developed HR's computational method, says it is more suitable than a physical model for describing conditions at an irrigation intake.

The new HR computer model is based on a standard flow simulation package. It allows the engineer to describe the flow geometry and sediment movement of a river reach in detail. The parameters of the proposed intake structures are then added and the model is run to simulate what happens. Field verification in the Phhilippines, which has some exceptional sedimentation problems has shown the model to work well. The model has also accurately simulated laboratory tests in intakes.

BOOK REVIEW

Title: Hydropower in Nepal: Issues and Concepts of Development
Author : ArjunP. Shrestha
Published by : Resource Nepal
Price: Rs. 250.00
pages :142

Development of Nepal's hydro-power potential for the welfare of the people has been illusive so far. Only a small fractions of the available potential is harnessed today. With addition of every new hydropower plant, the cost of electricity has gone up. Nepal, today, faces an inevitable power crisis. One of the major causes for inaction in this sector is lack of institutionalization.

The book under review partially deals with some of the institutional problems of power development. It discusses the practices of planning hydropower development by Nepal's water power triumvirate; Nepal Electricity Authority (NEA), Water and Energy Commission (WEC) and Ministry of Water Resources (MWR). The book first presents a general information on Nepal's hydropower resources and its present development status, the existing planning process of the sector is dealt next and finally the book proposes and alternative planning concept. The prevailing practice influenced more by interest groups than rational planning, argues Shrestha, has resulted in selection of uneconomical projects.

The second part of the book makes particularly interesting reading. It takes-up the Arun III project, as a case study to show the extent of arbitrariness in the planning and decision making processes. Its selection as the least cost option in 1987 in place of Sapta Gandaki, says the author, was "fraudulent" based on unreliable costs. The bias against impartial and independent evaluation of alternative candidate projects, according to the author, continued even later; when the interim government came to power. As a result, the Least Cost Generation Plan prepared in 1990 by the French consultant, EDF, imposed unrealistic constraints on other alternatives vis-a-vis the risky and uneconomical Arun III project.

In analysing why the whole hydro-power sector is in quagmire due to such manipulations, the author mentions of group within NEA structure. Notwithstanding, the role of NEA, MWR, WEC and Hydro-power Development Boards of HMG, albeit functioning in an adhoc manner independent of each other, the group was privileged to bypass formal decisions, to select projects. This concludes, the author, has resulted in what today stands out as the sad story of Nepal's water power development. The group's functioning went to the extent of even undercutting the corporate mandate of NEA.

The effort by the author, who presently heads Nepal's Pancheswor Project being studied by a consulting consortium, is praiseworthy as he discussed, how major decisions were taken in the power sector. Unfortunately the revelation is in-complete, as the issues are not related to any time frame. This could lead to falsification and have confusing implications as the man-agement of NEA has been reorganized last year.

To overcome the inefficiency and ensure institutional growth in the sector, the author proposes and laternative decision making process. The planning should be goal oriented with scopes for users involvement. Decision must be made from a series of alternatives. As external funds are prerequisites, Funding agencies have a role which however, should not be allowed to dictate project selection.

The principal institutions suggested in this alternative approach are MWR,NEA and WEC with clear-cut roles. The Water and Energy Commission has advisory role. And in this new set up, the author proposes to limit the role of NEA, which he says, should not be given any authority for long-term hydropower development planning. According to him, following factors make this necessary; NEA is prone to undue influences to select uneconomical projects, it has no proper institutional organization to develop project as all its schemes are developed by foreign consultants, as a commercial entity, it has less concern for study of projects as shown interest in selecting only those alternatives for which the government has arranged funds.

This view seems to suggest, and put on NEA solely, the blames for present adhocism. Actually the culprit is the individualistic approach, that has led to the total alienation of the general staff of NEA. Also at every step, the ministry has interfered with NEA's decisions, which is corroborated by Shrestha. Consequently, ever since its inception the organization was never allowed to function as a true corporate entity.

In his improvement proposal, the author assigns a stellar role to the MWR encompassing project identification, feasibility and detailed design. The ministry's involvement is essential because "decision regarding the arrangement of fund negotiations with financial institutions, land acquisition, selection of consultants and contractors require continuous involvement of MWR". NEA should be then handed over the package thus prepared for construction, operation and management and consumer services. The construction manager must come from among the 65 HMG/N hydro power project group within MWR. This, the author admits, is to assist proper utilization of the expertise within the ministry.

Essentially, the suggestions is to revert back to the system prior to the formation of the Electricity Authority, when Electricity Department and Nepal Electricity Corporation independently handled the tasks. The suggestion disregards the implication of such an approach on the existing man-power of NEA as the book makes no suggestions to streamline their functioning and improve efficiency. It is good to bring in technical expertise from a wider background including that from the ministry. But to propose institutional changes solely for utilising a certain section of HMG personnel is clearly against the spirit of alternative planing concept espoused by the author. And there is no guarantee that the new alternative would enhance efficiency, and that entrusting the pre-construction phase responsibility to MWR in place of NEA would stop the arbitrariness tht was seen in the past. The present NEA bureaucracy after all is the legacy of HMG style of functioning.

Another area worth exploring within the alternative planning concept; the role of private sector, is touched merely cursorily. The private sector is envisaged to develop, finance, construct and operate hydropower facilities. It is however, not clear what "develop" is intended to mean. If it is to relegate the tasks of identification, planning, construction and operation of hydropower projects to private hands, then the subject merits more thorough study and debates than a simple off handed statement. The suggestion, that some government organisation should handle construction of hydropower project and sell power to NEA at reasonable rate to relieve the burden of higher electricity cost, is also unconvincing. This can be achieved more straight forwardly by providing subsidy to NEA without having to establish a new bureaucracy.

Every one concerned with hydropower development in Nepal would find Hydropower in Nepal : Issues and Concepts of development a worthwhile reading. Although, justifications including cause-effect logics in some chapters would have enhanced validity of the proposed argument, the book deserves credit for dealing with and providing information, that so far were not exposed to public scrutiny.

Debates and discussions on issues having national implications were not considered important in the Panchayat System. As such exercise would be done in new Nepal, one can hope for objective analysis of the development efforts. This book would be one of the firsts in the continuing debates.

MAHESH P. ACHARYA

VIEWS FROM READERS

I found the January 1991 issue of Water-Nepal (Vol. 2, No 2/3) very informative and with effort, I was also to read all the articles. Yes, for a mechanical engineer like me who has migrated to the field of management, Water Nepal is far from easy reading. But I found it worth my while since I could learn a lot of things about water in Nepal. I look forward to reading your next issue.

The article – Small Scale Irrigation Development in Hills is very informative and has more than aroused my interest in this area.

FARMERS ARE MAJOR ACTORS IN IRRIGATION DEVELOPMENT

I would like to congratulate engineers and administrators at Farm Irrigation Water Utilization Division (FIWUD) now (SIWUD) for doing a laudable job of developing small scale irrigation schemes in hills and terai. The IRRs of some of the schemes is simply mind boggling, almost unbelievable. But then success always appears that way in our part of the world.

I am also concerned about those 17,000 odd irrigation schemes which are languishing in the absence of external assistance. I am sure that if we try hard, we can muster up finance for at least a few of those irrigation systems from our own resources.

I request Water Nepal to keep us informed about small scale irrigation systems in future too.

D.P.S Bhawuk

President

International Training Institute, Kathmandu.

I stumbled over the January 1991 issue (Vol. 2, Nos. 2/3) of Water Nepal just by accident. It was pleasing to realize that the much needed bulletin was here. I felt even better after reading the contents.

Kiran Shanker's article on "Science, Technology and Water Development in Vedic Times" provides an enlightening glimpse of the vedic philosophy. Let us hope that the water resources planners and developers will not forget Mahabharata while performing their duties. The obvious advantages of using appropriate technology, once again, were evident from Jon Lane's paper titled "A New Type of Tap for Use on Public Tap Stand;" although I do have some reservations about Mr. Lane's claims.

CAPITAL CENTERED ATTITUDE MUST CHANGE

I especially enjoyed the editorial which reminded us of favorable treatments the capital receives compared to rest of the nation, for water supply network planning and implementation. In fact, this seems to be the norm rather than an exception for almost all developmental activities. One of the probable causes of failure to meet the ambitious target, set for International Water Supply Decade- I tend to agree with the editor – is lack of openness and incoherent planning. Let us hope that things are going to get better in future.

My congratulations to all those involved in putting together an informative publication.

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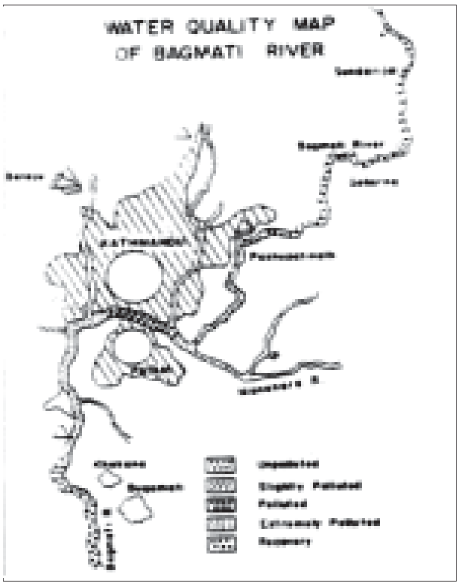
No other place in Nepal bears testimony to the harmful effects of haphazard urban growth than Kathmandu. The capital centered growth initiatives of the past have not improved lifestyle of the city's residents. This decline is evident generally by the deteriorating urban environment of Kathmandu and particularly by the holy Bagmati environment of Kathmandu and particularly by the holy Bagmati river that flows through its heart.

A study of Bagmati river's quality by Roshan R. Shrestha, Amaresh P. Karamacharya and Govind S. Ghimire from DISVI International shows very disturbing results. Physico-chemical and biological (macro-invertebrates and diatoms) investigations of the river and its tributary within the city were carried out for 7 months starting from January though July 1989.

Based on preliminary reconnaissance, 7 stations from the Bagmati river and 3 station from is tributaries were selected for water sampling. The 10 stations were i) Sundarijal, ii) Gokarna, iii) Pasupati Aryaghat, iv) Manohara in Phulbari, v) Dhobikhola in Baneswor, vi) Thapathali, vii) Bishnumati in Kalimati, viii) Sundarighat, ix) Chovar and x) Khokana.

POLLUTION OF BAGMATI MUST BE STOPPED

Important physico-chemical and biological parameters of the river water such as temperatures, pH, conductivity, hardness, BOD, COD, DO, O-saturation, NH_3, NO_2, NO_3, O-OP_4, detergents including bacterial as well as diatoms were investigated



from all the 10 sampling stations. However, the important macro-invertebrates of all the sampling stations were analysed only in January, March and May.

The values of all the physico-chemical parameters, studied except DO and O2 saturation 0/0, revealed an increasing order from sampling stations (i) to (viii) but decreasing from stations (ix) to (x), Centric diatoms and total faecal bacteria (Coliform) with very high contents (up to a million MPN) were found in polluted water whereas the abundance of acentric diatoms and greater diversity of macro-invertebrates was revealed in unpolluted water. On this basis, the river system within the city can be graded in to five zones (Figure).

As the urban expansion continues unregulated, plans are mooted for forming Greater Kathmandu. It is, however, common sense that in absence of coordinated management of services, structural changes only would have little effects. If the current state continues, even the slightly polluted and unpolluted zones of the river, few years from now, would be extremely polluted. The residents of the city should decide whether to allow to turn the river into a sewer or take time bound actions to prevent the holy river from turning into one.

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"We welcome discussion letters on the published articles and on matter of general interest. Letters with full name and address should be sent to the editor. Letters may be edited."

ACKNOWLEDGEMENTS

B. R. Regmi, Deputy Director, NEA for editorial support

Research Focus U. K.

Water Aid, Kathmandu

WATER NEPAL welcomes articles and research reports on topics related to water and its uses. We also welcome reports on current water development programs in Nepal and elsewhere. Neatly typed and double spaced compy of the manuscript should be sent to the editor, along with name of authors, qualifications and occupation. Figures and sketches should be neatly drawn, labelled and submitted in separte sheet, and the text should indicate the location. Formulas and mathematical symbols must be neatly drawn or type written. Reference materials should be clearly mentioned.

WATER NEPAL

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NEPAL WATER CONSERVATION FOUNDATION

Published by Ajaya Dixit for Nepal Water Conservation Foundation
Layout, Design and Typesetting by Kiran Shakya (Ph. 216118)
Printed at Hill Side Press P. Ltd., Kha 2 - 5, Kalimati Ph : 271755