WATER NEPAL

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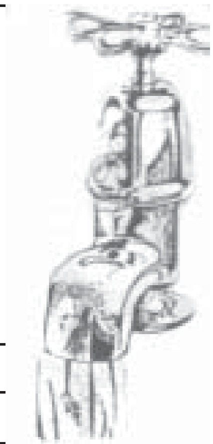
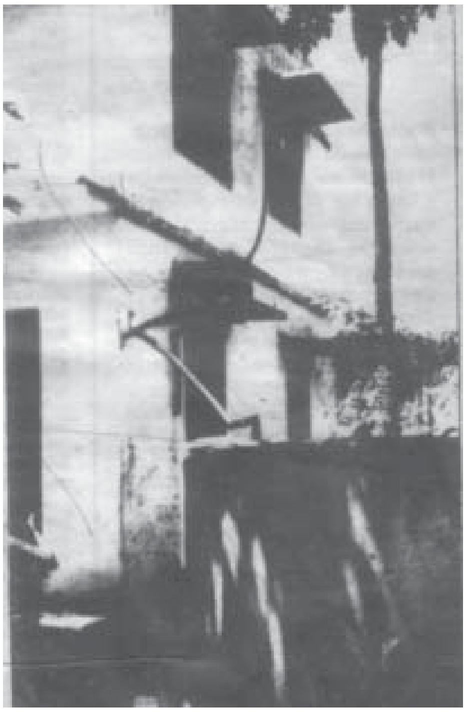
WATER DEVELOPMENT BULLETIN





RAIN WATER CISTERN SYSTEM AT CHITWAN NEPAL

IN THIS ISSUE

THIS ISSUE IS DEDICATED TO THE SELFLESS SACRIFICE OF ALL THOSE WHO ATTAINED MARTYRDOM DURING THE MOVEMENT FOR RESTORATION OF DEMOCRACY. WE PLEDGE TO WORK FOR BUILDING A PROSPEROUS AND NEW NEPAL

WATER
NEPAL

Editor
AJAYA DIXIT

Water Nepal is published once in three months in English.
Water Nepal aims to function as a forum for sharing of experiences among technologists, engineers, and scientists engaged in different aspects of water resources development in Nepal. It is distributed among the institutions and individuals that are involved in development and management of water resources.
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A DROP NOT WASTED IS A DROP SAVED WATER IS LIFE. CONSERVE WATER

EDITORIAL

Flood Hazards

Flood in the south Asian Region, perhaps is the most severe natural disaster, both in terms of the damages and cost of alleviation. Annual flood damages run into staggering proportions with widespread losses of lives. In the region, flood results because too much rain falls in a short period to be safely drained out of the lowlands, where in the deltaic region occasionally inland flows synchronise with high tides. In recent times, the pressure of the population in both the upper and lower basins is the reason of increased flood hazards.

The genesis of flood can be traced to the increase in flow caused by intense rain, snows melt and surges generated by bursting of dams; glacial and/or landslide induced. As the flow interacts with the river course and its fringes, flood results. Recurrence of major flood in the region in the past few years has given rise to the argument that upland land use changes, particularly deforestation has caused the ordeal.

The destruction caused by flood has increased due to haphazard alterations in the drainage network and flood plain occupancy. With population growth, areas susceptible to floods and in extreme cases, even older river courses have been used for buildings, bridges and developmental works. These growths in the flood plain obstruct flow. As a result, stage, the level to which flow occurring in the river, with a particular magnitude reaches, has been showing steady rise. A flow that passed safely earlier has acquired flood form due to water entrapment.

It is within this postulation, the impact of changes in land use in river flows needs to be evaluated. Increase in flow is perceived due to changes in the infiltration rate; the process that allows water to enter underground. Physical changes in land does affect the rate, but it is governed more by moisture availability. In a continuous moisture supply situation, such as the monsoon, when the infiltration capacity is saturated, presence or lack of vegetation in the drainage basin would make little difference in major flood. This relationship between flood and deforestation however, needs to be still scientifically validated. Deforestation (including ground vegetation) on the other hand, induce more loss of soil from land surface. The resulting sediment response, aggravation, is associated with progressive rise in the stage. In the lower reaches, this hydraulics is more complex, and has ramifications in the flood scene.

Successive flood mitigation programs show continued emphasis on structural measures to keep flood water away from the centers of population. Embankments, and reservoirs having flood-absorbing capacity with or without hydropower and irrigation as additional benefits, have been built. These approaches show very little attempt to include other non-structural measures. That a comprehensive flood alleviation approach always proposed combination of both the measures seemed to have been restricted to academic discourses, mostly within class rooms. Their practical uses remained and continue to be sporadic.

The logic of this concentration on structural measures probably developed out of pursuing the path of least resistance. Embankments and reservoirs are evident and straight forward options, compared to the non-structural measures, which are more time taking and difficult. For a while, the measures provided relief and also instilled a false sense of security among the populace. But subsequent events have shown that these alone do not contain flooding.

The problems of flood have no foreseeable remedies with compartmentalisation both in the orientation and focus. It must be a total and continuous process within the broad paradigm of development. Implicit in this approach are the difficulties imposed by the problems of the runaway population growth, whose momentum has so far

Cover Photo credit : Ajaya Dixit, Bikas Rauniar outwitted methods to stabilise it. Since, flood problems are also linked closely to population growth, entry into social and cultural mainstream is essential for effective control.

The approach presents several intractable problems, as it treads over the undefined and non-quantifiable. Wisdom and sensitivity are needed, as much as "good engineering" supported by sound and scientifically based information. The extent of information particularly can be an enormous asset, which is severely lopsided compared to the technological advancements, and available choices.

Two major areas, which can substantially improve the capability of flood managements, are the uses of satellite mapping and hydrological models. While satellite photography enables preparation of high-resolution maps, including zoning of flood hazard areas, available models provide a way of simulating flow along the river course. Both can be combined to prepare stage inundation maps of the flood plain, which would be effective in implementing both structural as well as non structural flood control programs. Flood warning, response and rescue plans, formulation of law regulation to check encroachment on flood prone areas, and thereby reduce the risks of inundation become possible.

A potential forward leap through this approach is hampered by the dismal state in which hydrological and related data exist in the countries of the region, inadequate but generally non-existent. And to make the matter worse, they continue to be accorded low priority. The situation stems from an inherent conflict that plagues our thinking which accepts among others, data as a luxury incompatible with the state of affairs.

The changes can only be brought about by a fundamental shift in perspective, and does not derive from piecemeal efforts. Today even the US Army Crops of Engineers, attuned in the uses of structural ways for flood control is pursuing non-structural measures for mitigating the hazards. Those concerned with the responsibilities of managing flood hence need to understand the complexities for sustainable flood mitigation and follow appropriate measures.

THE OTHER SIDE OF CALIFORMIA'S WATER DEVELOPMENT

Dipak Gyawali

(*Water in the western United States, is developed and managed on a scale that almost defies imagination Mammoth dams, aqueducts, and canals cut beneath mountains and traverse through deserts to bring life to the water hungry south west. The experience of this development has indeed been instrumental in ushering the modern art of water development and management. But, behind this human feat also lies the story of hardship and pain that the development has caused to the poor, other regions, and to the environment. This article explores this other side of California's water development. Arguing that the development preamise was based more on resource politics than on rational water economics, the author cautions against replication of this model. For us in the third world, he suggests, this experience, should serve as an example, to take an approach that evaluates all possible options of water development. The one that meets the needs of a sustainable and dignified living should be pursued.* Editor)

The molding of California into the world's pre-eminent hydraulic civilisation is now a legend that is enshrined in textbooks of water resources engineering around the world. It continues to influence the thinking of new entrants to the profession of water management by becoming the etalon of success. California's massive water works literally made the deserts bloom; and they have allowed the Golden State to produce 60 to 80 per cent of many American crops, especially tomatos and other vegetables. These feats have now transmogrified the process of California's water development into a paradigm for fresh engineering graduates that inadvertently channels them to look at the problems of their own places and time with the pre-accepted belief that replicating the Californian experience around the world is unquestionably good in itself.

However, as with all legends, it is the glory that receives the hosannas while the pain is relegated to the limbo of forgotten things. It is said that behind every large fortune is an equally large crime and California's water induced wealth too has a dark side to it. Behind it lie murky and unpublicised tales of 'crimes' against the poor, against other regions of the country, and finally against the environment. Not only our own engineering community but also the many aid agencies nurtured along the Californian paradigm of development may well consider the possibility that, in importing this mode of water induced development, they are also importing the lifestyle associated with it and its history of resource politics.

California is water rich in its northern half above San Francisco and water poor to the south where the Mojave Desert lies. Due to a population growth in the south from the annexing of Mexican land holdings following Mexico's defeat in the war as well as Federal encouragement to migrate west to relieve the unemployment pressure building up in the East Coast,[1] economic and political power slowly began to grow around Los Angeles and San Diego, cities on the fringes of the Mojave where (as northern Californians like to say) "God never intended man to live in large numbers". This particular political economy began to flex its power and initiated a process of colonisation of water resources to feed its hungry growth a process having an uncanny resemblance to what is underway in the Ganges a politically stronger and economically faster growing south.

California's waterscape is dominated by three major projects. The Central Valley Project is the most grandiose. It transfers water from northern California and taps many of the rivers for irrigated agriculture in the Central Valley.[2] The Imperial Valley Project diverts the stored waters of the Colorado River to irrigate the Imperial Irrigation District east of San Diego.[3] And the third major project is the water supply scheme for the city of Los Angeles, which is politically the most dramatic one. It expropriated the waters of the Owens Valley and ruined its livestock farming as well as its agriculture,[4] drained away most of the streams which fed the spectacularly beautiful Mono Lake, and also staked claim to the waters of the Sacramento-San Joaquin Delta which sustains the ecosystem of the San Francisco Bay.

In a short article, at the risk of being accused of making sweeping generalisations, one is forced to try and capture in a nutshell the vast complexities of intertwining problems of Californian water resources development. One must, however, bear this risk to appraise the majority of those thrust with the task of water management (who will not have the time or the patience to delve into the mountain of literature on the subject) of the salient issues. Leaving aside the hosannas for other articles, the painful issues relate primarily to injustice to the poor, to other regions of the country, and finally to the environment. It is almost as if well-being is a constant out of which the good can be filtered and concentrated to occur in a particular place and time while the undesired evil is transferred to another place, another time, another generation and other people.

An interesting impact of Colifornia's water development on the poor has been in the distorting of the provisions of the Reclamation Act of 1902 and the related Homestead Act which limited federally subsidised irrigation to only family farms below 140 acres.[5] It was inconvenient, to say the least, to the large landowners who devised and exploited various loopholes to bypass this limitation. The result is that today the major oil companies who own much of the Central Valley's agricultural lands (which contain massive deposits of low grade oil which are used as future reserves), are the real beneficiaries of the federal subsidies, Indeed, these 'farmers' pay only $6.50 per acre-feet of irrigation water which has a marginal economic cost of supply of $200 per acre-feet.[6]

In the agri-business townships in the command area of the Central Valley Project, the sociology of systemic poverty is worthy of serious study. The Chicanos—cheap and often vaguely legal Mexican workers—and other socially disadvantaged groups who harvest the agri-business crops are exposed o very high levels of pesticide from continuous aerial spray, and the retail market is structurally so designed that what they earn is recouped in the only company stores around. Either that or through prostitution.

The latter phenomenon should be looked at in conjunction with the fact that till well into this century there existed a racially discriminatory law which prevented foreign workers (read Chinese and Indians of South Asia) from importing wives. As a result, while the Central Valley has exotically named towns such as Madras and Delhi, very few Indians can be found there. The only groups that survived are the Sikhs of Yuba City and the Chinese in Chinatown. The problems of the marginalised poor was so serious that the late Paul Taylor, professor of economics at Berkeley and a frequent visitor to Nepal in the 1950's and 60s' devoted the last years of his life to a virtual crusade for improving their lot.

Water resources development in California has occurred at the expense of other regions, in both the US and other countries. Louisiana at the month of the Mississippi Delta is about the only ecologically sensible place in the United States besides Florida where rice can be grown. Because of the abundant Federal and State subsidised water provided to the arid deserts of Bakersfield in the Central Valley and on the fringes of the Mojave in the Imperial Valley areas with ample sunshine and high temperatures—the Lousiana farmers could not compete against cheap Californian rice. At present, it is the Thai farmers and rice exporters who are facing the onslaught of 'rice politics' from California, this being the major element souring an otherwise excellent US-Thai relationship.[7]

Because of extensive diversion of the waters of the Colorado by the All American Canal for chemical farming in the Imperial Valley, the Colorado became a salinity drain as it entered Mexico. Thankfully for the Mexicans, a clause existed in the river basin agreement which forced the US to build a desalination plant near Yuma so that the Colorado plant near Yuma so that the Colorado could carry purer water into Mexico. The energy economics involved in this obligatory clean-up is horrifying and points to the possibilities that the Americans are probably better off not growing rice in a Californian desert and irritating the Thais. Americans don't eat the stuff anyway. One sees shades of this phenomenon in the Rajasthan Canal.

Strangely, the development of water resources in the Central Valley destroyed navigation as an industry in the San Francisco Bay and the Sacramento River.[8] The major political actors in this conquest were the railway companies (which probably are still the biggest landlords in the US Army Corps of Engineers and the US Bureau of Reclamation involved in building the irrigation works which needed the railway lines as well as land for canal right-of-way. The Crops of Engineer's involvement is particularly ironic since they were originally mandated by the US Congress to develop and protect navigation as a means of ensuring the free flow of commerce between these united states. Again one sees the shades of this path of evolution in the destruction of steamboat navigation in the Ganges after the advent of the Indian Railways.[9]

The impact on the environment from extensive remolding of Nature's regime in the case of California's water development is unfolding thick and fast. It is not just the furbish thick and fast. It is not just the furbish lousewort or the endangered spotted owls that are the issues: the very survival of the Californian way of live is threatened. Chemical poisoning of the surface and ground waters of the land from chemical agriculture made possible by cheap irrigation water is leading to increased instances of cancer, sterility, handicapped children and other horrors.[10]

Equally serious has been the rapacious mining of the soil. The US Soil Conservation Service says that the soil of nearly one-fifth of California's prime farmlands is being carried away by wind and water faster than it is being replenished by nature, primarily because irrigated cropping practices and the nature of the market forces value increased productivity in the short run and congenitally ignore soil destruction in the long run.[11]

California's water development as well as that of all of the western United States, presents a major challenge to the theories and practice of water economics (or in a larger sense) water management, since the venture almost seems to prove that there is no such thing as 'Water economics' but only 'water politics'. Indeed, the very methodology of Benefit - Cost Analysis was invented in the 1930's and developed thereafter (in the celebrated

'Green Book') for the purpose of allocating scarce federal resources for water development among the many competing claims by different states. However, most decisions on major projects have been taken on grounds of resource capture more properly in the realm of the politics of power than in that of rational pure economics. Benefit-Cost Analysis has been used in the United States more as a post facto justification for a decision already made than as an aid in making the decision itself. It is now being used very effectively by the environmentalists to stop projects by showing that the real costs of water resources projects out weight the stated benefits when one includes many hidden social and environmental costs.

In order to further develop this methodology and enshrine in it the principle of rational decision making, the US Congress enunciated a Congressional Statement of Objectives in 1962 (which was enacted as part of the Flood Control Act of 1970) which states: "It is the intent of the Congress that the objectives of enhancing regional economic development, the quality of the total environment, including its protection and improvement, the well-being of the people of the US, and national economic development are the objective that are to be included in federally-financed water resources projects and in the benefits and cost attributed thereto, giving due consideration to the most feasible alternative means of accomplishing these objectives."[12]

The many executing agencies of the Federal and State Governments faced difficulties in implementing this principle. A decade later in 1973, an Executive Order of the President of authority to the Chairman of the Water Resources Council and the Director of the Office of Budget and Management to effectuate this policy of the United States.[13] Extensive work was done for a decade thereafter to design effective Benefit-Cost metrologies that would try to optimise along four accounts: those of national economic development, of environmental quality, of regional economic development, and of other social effects.[1414]

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However, agencies-still had difficulties in balancing the four conflicting accounts; and the entire effort to arrive at rational decision making regarding water resources development was repealed by the Reagan Administration in 1983.[15] The only lesson that seems to have emerged from this exercise was that one cannot give a federal bureaucracy more than one account to optimise.

Because of the opposition of an environmentally and difficult to convince skeptical Californians of the need for further large dams and grandiose water resources projects. The peripheral Canal to augment water supply to Los Angles has been effectively derailed. The issues regarding Mono Lake diversions are also being challenged in the courts. As a result, the Los Angeles Department of Water and Power as well as other utilities are being forced to curb their (so far) insatiable appetite for fresh water. They are advocating a 'wholesale water market' where they can buy water from the more water profligate argi-business at lesser cost than from the large construction schemes; and Californians are beginning to adjust to the possibility that they may just have to live without green lawns in the desert heat. For California, and indeed for most of the United States, the age of large dams is effectively over.

For water resources development in the third world, good dams and bad dams will continue to be built in future. What we have to be sensitive to are the issues of economics and equity regarding these mega-projects. The prime questions are who benefits (not just the people in the abstract)? How (by what legal mechanics) are the benefits are included, but major costs are excluded or underplayed with weak assumptions? Finally, as custodians of the land rather than absolute masters, how will this generation answer to those in the future if a sustainable resource base has been mined away in the name of economic efficiency? Water resources development is not merely a question of the mechanics of how to mould a river regime: it is mostly about asking why we are trying to do it and seeing whether better alternative means exist that meet the needs of sustainable and dignified living.[16]

NOTES

1. See Carey Act of 1884 and the Reclamation Act of 1902 and their significance to Theodore Roosevelt in controlling the political bombshell of growing hoboism as described in Kahrl W.L., 1982. Water and Power: The Conflict Over Los Angles's Water Supply in the Owens Valley; University of California Press, Berkeley; p 34
2. Association of State Water Agencies 1979 The Sacramento-SanJoquin Delta: A Summary of Facts: Sacramento.
3. Hundley N. Jr. 1975 Water and the West: The Colorado River Compact and the Politics of Water in the American West; University of California Press, Berkeley. [4] ibid. Kahrl 1982 Water and Power.
5. El-Asry M. and Gibbons D.C. 1986 Troubled Waters: New Policies for Managing Water in the American West; World Resources Institute, Study 6; Washington D.C.; P 62 Also LeVeen E.P. 1978 Reclamation Policy at a Crossroads; Bulletin of the Institute of Government Studies, U. of California, vol. 19, no 5.s
6. Dennis H. 1981 Water and Power: The Peripheral Canal and Its Alternatives; Friends of the Earth San Francisco; P 96.
7. For an excellent treatment of international grain politics, see Morgan D. 1979 Merchants of Grain: The Power and Profits

of the Five Glant Companies at the Center of he World's Food Supply; the Viking Press, New York. Elements of this politics were much in evidence during the so-called "Korea-gate" rice export scandal, which rocked the Us Administration. In the last few years, the Japanese too have been sucked into the vortex of this politics.

8 Jackson W.t. AND Paterson A. M. 1977 The Sacramento-San Joaquin Delta: The Evolution and Implementation of Water Policy; Dept. of History, University of California, Davis; California Water Resources Center Contribution No. 163

9 Bernstein H. T. 1960 Steamboats on the Ganges: An Exploration in the History of India's Modernisation through Science and Technology; Orient Longman Ltd, Calcutta.

11 Gilliam H. 1986 Californian Farming is Digging Its Own Grave; This World, April 6; San Francisco.

12 42 USC 1986-2

13 Executive Order 11747 of Nov. 1973.

15 Federal Register vol. 48 no. 48 March 10, 1983

16 Gyawali D. Aug. 1986 Shiva in the Land of Vulcan: California Water and the Export of a Lifestyle; International Dams Newsletter, vol 1 no. 4, San Francisco.

CATCHMENT MODELLING AT LOCH FLEET, SCOTLAND

George Fleming, G. G. Rufai, S. Dowling, and Mike S. De Silva

(*Conceptual deterministic models of the hydrological systems have wide applications in analysing catchment responses for variety of external influences. The uses of mathematical models however, depend upon the extent and quality of data available for the purpose. This article based on the study carried out at University of Strathclyed, Glasgow, UK, discuses the application of Strathclyde River Basin Model (SRBM) to understand the impact of soil chemistry of Loch Fleet's catchment on its specific hydrological sub-processes. The conclusions can be helpful in assessing ameliorative actions for minimising acidification of the loch.* Editor)

INTRODUCTION

The decline in fish population in lochs in south-west Scotland, Scandinavia, North America etc., is suggested to have resulted because to the industrialised nations pumping an ever increasing amount of acidforming gases such as sulphur dioxide and nitrogen oxides into the atmosphere. These emissions have led to acid deposition.

Little correlation has been found in recent trends of emissions and changes in rainwater chemistry, suggesting they are not the sole cause of the problem. The existence of biological and other chemical changes within the catchment over the same period is now generally accepted. The relative influence of each possible cause of acidification remains to be quantified, even in broad terms. Acidification of surface waters implies the progressive loss of neutralising capacity from catchment soil, and addition of base minerals is an essential step in restoring affected soils, lakes and streams.

Soil/catchment/lake treatment techniques need to be developed and tested to find the most effective and economic method. Assuming that the chemical balance in a lake is influenced largely by the catchment soils, then it is preferable to alter catchment yields of the elements concerned rather than to treat the lake directly, especially if water retention time is short.[1]

Loch Feet is a small acid loch in Galloway south-west Scotland. Since the 1960's fish life has been absent in the loch due to adverse water quality. The Loch Fleet Project was undertaken as a five year programme in 1984 to assess its water and chemical balance with a final aim of introducing trout's to the loch,

The catchment modeling study was undertaken by the Civil Engineering Department of University of Strathclyde with direct emphasis on the water balance study of the Loch Fleet's catchment. The objectives were to:

i Establish a mathematical model of the Loch Fleet catchment which, as accurately as available data would allow, simulates the various components of the water balance.

ii Use the model to in fill missing time-series of the runoff record by the input of recorded rainfall data to the model and generate a simulated runoff output.

iii Use the model to provide information on the division of water between surface and sub-surface runoff from selected sub-catchments, and to comment generally on the mutual interaction with land management.

iv Make recommendations on the extension of the modeling technique to sediment and water quality response.

METHODS AND DATA COLLECTION

The method involved the use of an existing Stranthclyde River Basin Model (SRBM)[2] for carchment hydrology, based on the Stanford Watershed Model IV[3] and Hydrocomp International.[4] These models have seen continuous modifications giving rise to

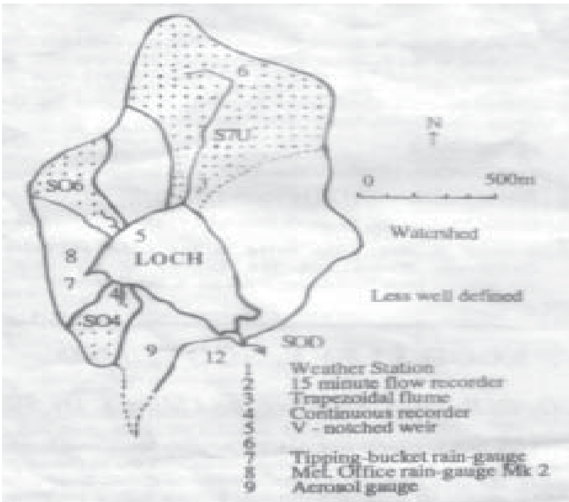


Figure 1: Loch Fleet Catchment

the current version[5] used in this study.

The simulation model is designed to accept input from any number of recording gauges and to produce stream flow at series of points in the stream channel system. These are flow points, in the case of Loch Fleet, the outlet of sub-catchments 4 and 7, Figure 1. The area above each point may be divided into segments for each rain gauge. Segments are selected from topographical considerations or by constructing a Thiessen polygon. The general model will continuously calculate the streamflow from rainfall and evaporation in the whole catchment, and from flow measured or calculated at upstream flow points. The simulated stream flow is continuously compared to the recorded stream flow until the best fit is obtained.

Site visits have been made to Loch Fleet and limited infiltrometer tests conducted, but generally no major sampling has been undertaken. Data has been supplied by other project investigators and sponsors.

PRINCIPAL FINDINGS

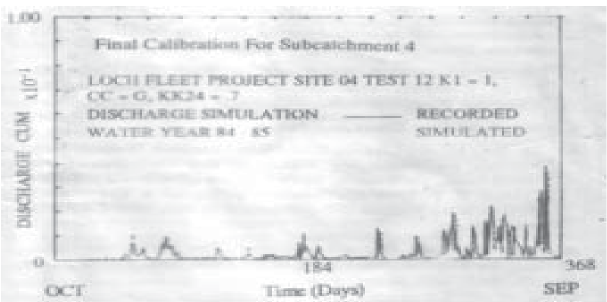
There were no adequate rainfall and runoff data for the 1985/86 water year for a direct comparison to be made with the measured through flows. Nevertheless, a comparison was still made to demonstrate the various flows achieved through the use of the model. By taking layers 1-3 as overland, interflow and groundwater flow respectively in the model, a direct comparison

Table 1
Catchment Runoff

Flow Component	Subcatchment 7	Subcatchment 4
Ground Water	20.5	32.3
Overland	47.7} 79.8*	59.2} 67.7*
Interflow	32.1} 79.8*	8.5} 67.7*

* fast and slow runoff

was made of the measured through flow data. This shows that if overland flow and interflow (or quick return flow) are summed



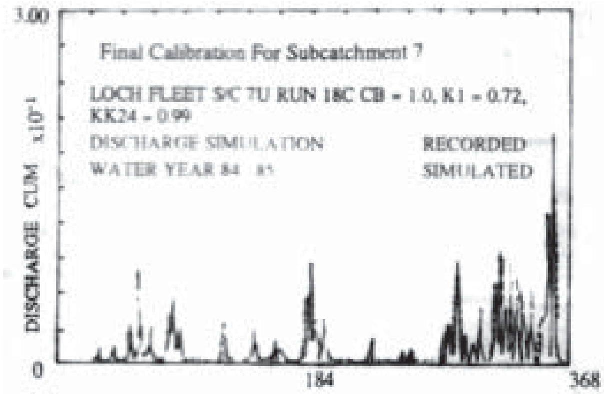


Figure 2: Simulated and Actual Flow

together then subcatchments 4 and 7 will tend to have 67.7 per cent and 79.5 per cent of 'rapid' runoff Table 1. This lumping together is reasonably

Justified and overcomes what seems to be a discrepancy in interflow between subcatchments 4 and 7. Figure 2 and 3 show the final fit of the recorded and similated flows of subcatchments 4 and 7 respectively.

In the final run for subcatchment 7 the relationship between point rainfall and the average segment rainfall was reduced from 1.0 to 0.72 (kl model parameter). This tends to indicate a source of error in the measured data, but in the model it tends to decrease the amount of rainfall reaching the land surface. Errors may exist in flow data, evaporation data or in subcatchment areas. The utilisation of the data can be improved by the use of a data management system, particularly for checking the precipitation recorded throughout the data network of the catchment.

With the provision of new weather station, rainfall data from the SSEB and using a calibration parameter set, it was found that the Kl factor could be returned to 1.0, and a satisfactory answer still obtained. This result would indicate the rainfall as a more likely source of error than the other factors already mentioned.

Sub-catchment 7 is dependent on its sustained flows from both overland flow and interflow and sub-catchment 4 is dependent on overland flow with little interflow and groundwater flow.

Division of rainfall shows that groundwater reaches its maximum during August-September and would not be as significant if the peat layer was not as thick and porous and able to sustain this process in sub-catchment 4.

Evaporation reaches a peak in June August with precipitation only 7 per cent higher in June but more than 70 per cent higher in July and August. This suggests a loss of water from the peaty layers by evaporation during June.

CONCLUSIONS

Both sub-catchment 4 and 7 develop high moisture storage conditions that severely limit infiltration rates. From simulations it can be deduced that reasonable water balance has been achieved for sub-catchment 4 and 7, but the Kl factor (the ratio of the average segment rainfall to the rain gauge for that catchment) for sub-catchment 7 is low. This means that water may be escaping from the sub-catchment through leakage and/or underflow at the measuring site or that errors exists in the measured data.

It was also concluded that the sub-catchments behave differently from each other and should be treated independently in terms of their hydrology. Data required for the model is given in table 2.

Table 2
Data Requirements for SRBM

DATA CLASSIFICATION

HYDRO METEOROLOGIC PARAMETERS	PROCESS PARAMETERS	PHYSICAL PARAMETERS
	Interception Storage	LAND SURFACE
Precipitation snow, rain, hail, dew	Moisture Storage Surface and lower zones	Elevation Area zones Overland Flow Length
Evaporation	Infiltration	Geologic Type
Radiation short and long wave	Interflow Transpiration	Vegetation Cover(Areas) Soil Type and Size Classification
Temperature air, water and earth	Consumptive Water used by Vegetation	Land Use Types Land Formation Classi fication
Wind Speed and Direction	Overland Flow Roughness	Impervious Areas
Humidity, Vapour Pressure	Time Delay Hiatogams	NATURAL CHANNEL NETWORK
Cloud	Unit Hydrograph Responses	Contributing Area
River Stage	Muskingham Coefficients	Lengh, Slope, Cross-Section and Roughness of Channel
Streamflow Volume and Velocity	Recession Rates interflow, ground water	URBAN CHANNEL NETWORK
Groundwater Level Diversions	Groundwater Flow Inactive ground water	Length, Slope, Drainages Area, Culvert Diameter, Roughness
Tide Suspended Sediment Concentration	Snowmelt Parameter melt rates due to radiation, condens ation, convection, ground	RESERVOIRS Contributing Area, Maximum Elevation and Storage, Spillway Crest
Bed Sediment Load	Snow Density Snow Pack Water Content maximum volume equivalent Erosion Rate Parameters	Minimum Elevation and Storage, Spillway Crest Area-Elevation-Capacity-Discharge relationship, Operating Rules

DATA CLASSIFICATION

The use of a continuous hydrological simulation model has highlighted the existing data deficiencies and in some cases a lack of consistency between rainfall and runoff data. In general it would appear that errors occurring in either collected data or in the modelling are accentuated by the flashy nature of the land surface hydrological response at Loch Fleet.

RECOMMENDATIONS

A summary of the recommendations are as follows:

a) The rainfall gauging network should be better apportioned to represent variation in input data.
b) Detailed collection of good quality runoff data is required as overland flow dominates.
c) Regular calibration of recording flumes is necessary.
d) An investigation of leakage and/or underflow near the recording flumes required.

The major component of runoff is surface (or near surface) flow. Therefore, liming the surface should lead to rapid improvement in water quality in the short-term is less certain and dependent on fluctuation in surface flow.

It was recommended that the SRBM be combined with modelling of the water quality. Processes to provide a quality model, which can be used in order to obtain a figure for the longevity of the various treatments at Loch Fleet and to extend the use of data in assessing other catchments.

The effects of snow processes and the attenuation of the loch itself were not considered during the study. However, snow processes are unlikely to be dominant. Nevertheless, the SRBM can be used to model the loch outflows and hence the effects of the loch's attenuation on the quality of water.

Furthermore, in view of the significant impact of changes in catchment soil chemistry and its influence on the Loch. It can be concluded that studies of this nature are invaluable in helping the assessment of ameliorative actions. Overland and interflow should ensure that techniques such as surface liming of the catchment are effective in maintaining loch pH status.

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REFURBISHING OF HYDRO-POWER PLANTS-AN APPROACH FOR AUGMENTING SYSTEM CAPACITY

Ganesh B Shrestha

(*As the Electro-mechanical and civil engineering components deteriorate over time, the performance of a hydroelectric plant is lowered. This process is also accelerated by lack of regular maintenance. Available power in the system is short of the demand at many places. Refurbishing of an existing hydroelectric system can upgrade its performance and solve part of the power crisis. This article looks at the processes of refurbishing and proposes that the approach should receive attentions in current policy of power development. Timely maintenance can stall undue deteriorations of a hydroelectric plant and avoid the immediate need for refurbishing, which however, remains an option for system upgrading in the future.* Editor)

INTRODUCTION

Hydropower plants in many developing countries are built to sound standard and specifications. These utilities are therefore, expected to perform with high degree of reliability throughout their economic life. However, power systems in many cases do not function as envisaged. Defects in the systems can arise at different stages. Even projects that are designed meticulously, and constructed can have functional defects, affecting performances.

The resulting shortfall in power availability hampers development and even, day to day life due to load shedding, power cuts, voltage fluctuations etc. Refurbishing of hydropower projects can bridge this gap between growing energy needs and shortfall of power.

REASONS FOR DETERIORATION

Deterioration of a power plant can result from both the technical and non-technical reasons. Part of the problem is due to the limitations. Imposed by the hydrological-hydraulic universe. Many third world countries do not have sufficient hydrological database. In many cases, design of even large hydropower projects are based on insufficient and poor quality flow data, let alone, put more focus on data augmentation. Furthermore, certain parameters essential for the design are lumped either for lack of information or limitations of funding for detailed and thorough investigations. Many projects have developed major flaws within first few years of operation.

Defects in power systems also arise due to number of other reasons. Lack of regular maintenance for example, can lead to deterioration of a particular component. As the specific problem does not get attended, deterioration continues over the time. A stage is then reached when the plants' output is affected and lowered; only about 60 per cent of the rated design. This reduction, when coupled with the transmission and other forms of unaccounted for losses, which in some cases are as high as 40 per cent, significantly lower the efficiency of the power system.

Some of the technical factors are more specific and can be controlled better. Superior technical quality is a function of appropriate design and constructions procedures, with stringent quality control mechanisms at all stages. Defects in power plants can also arise due to non-technical factors. In many third world countries, these constraints are the major irritants and accentuate deterioration of the plant's performance. Some of the non-technical limitations can be summarised as:

Operation and Maintenance

- Lack of institutional approach for utility's operation
- Negligent approach.

Resource

- Budgetary constraints
- Mis-utilisation of allotted funds
- Lack of physical facilities

Management

- Spatial hierarchy in the administrative process
- Poor relation with consumers
- Absence of objective criteria for monitoring and evaluation
- Lack of incentive

Manpower

- Assignment of non-relevant per sonal
- Lack of in-service training oppor tunities for all levels
- Limited opportunity of access to related expertise

Attitudinal Factors

REFURBISHING PROCESS

The growing energy demand can be met by implementing new power projects, such as construction of a hydroelectric plant. Hydropower development, however, is a long and time consuming process, both for securing financial arrangements and for designs/installations. Getting financial resources, either through multi/bilateral funding or internal resources mobilisation in recent times have become difficult as more secure investments are given priority by the funding agencies. These constraints notwithstanding, decision-maker involved in power sector must evaluate all options for augmenting the scenario of energy growth. Rehabilitation and refurbishing of inefficient plants may take less time, resources, and could be another approach, which would more preferable.

Refurbishing is the process by means of which an old plant is restored as a new one. It is also undertaking repairs of the components that for the lack of regular maintenance have deteriorated. The process of refurbishing needs careful investigations. It calls for first, detecting the defect, and then identify the reasons for deterioration of the system. The information collected must be analysed for costing, and organising management of the actual refurbishing activities. The estimate must also include the assessment of consumables and recurrent costs.

A major decision in the rehabilitation approach is to relate the investments, to the benefits accrued in terms of extended life and improved serviceability of the utility. Analysis of the investment to be made is, therefore, very important and critical. Particular attention is needed to evaluate the factors which in the first place may have been responsible for unsatisfactory performances.

Requirements for refurbishing cannot specifically be defined during the planning stage, as many of the factors can not be foreseen. The actual process of refurbishing could encompass scores of temporary activities and diversions. While the maintenance activities are continuing, the utility needs to be kept operational, because energy demand may be critical, and also because the losses due to shut down of the plant could be avoided. The level of uncertainty as a result is much higher than that involved in a new project. As many of the non-quantifiable, unforeseen, and attitudinal factors have be to incorporated in the programme planning and subsequent management are complex.

CONCLUSION

Refurbishing of hydropower plants, that are more than 20 years old, could be an attractive proposition and the approach demands serious contemplations. Sound technical and economical analysis of the refurbishing option need to be undertaken so that the approach could be evaluated vis-à-vis development of a new power project. Only with such a basis can the programme be undertaken in the most cost-effective manner, where the investment is set in a right way related to performance. Continuing support for the operation of a refurbished plant is another extremely important issue. It would be of no use to leave a refurbished plant exposed to the same situation that in the first place caused its deterioration.

Repairs and maintenance of not just hydropower plants but all infrastructure systems of the built environment is an area, no society can afford to ignore. For example, capacities of motorways and bridges need to be augmented to motorways and bridges need to be augmented to accommodate more and heavier traffic. Water supply systems and sewer mains need to be flexible to accommodate the burgeoning urban growth, which in many cases do not follow the forecasted pattern. Similarly, irrigation systems must continue to function.

Refurbishing of hydroelectric plants should also consider issues such as transfer of technology and support of experts. Experiences of existing manpower can be an asset in the refurbishing process, and should be included in the programme.

SAVE MONEY
CONSERVE
ELECTRICITY

RESEARCH REPORT

UNSTEADY FLOW MODELLING IN BUILDING DRAINAGE SYSTEMS

Building drainage systems conduct 'black' and 'grey' waste water discharges from basins, toilets, baths, showers etc. within the building to the sewer in the road. The system comprises vertical 'stacks' and near horizontal pipes laid on each floor. The flow are transient and cause partially full and full-pipe flows. For the last 10 years the sizes of pipes have been based on an estimate of the probability of use of an appliance and steady open channel flow analysis.

This traditional approach is based on observations carried out some decades ago and so excludes modern plumbing practice. It neglects the inherently unsteady nature of appliance discharge and so takes no account of the attenuation of the peak flows as they travel through the system. Many drainage systems incorporate a large number of junctions and so the traditional procedure result in overdesign and this in turn can lead to greater deposition of solid and increased maintenance expenditure. This effect is exacerbated when water conservation measures are introduced.

Improved computer based methods of analysis of the unsteady part-full pipe flows is being developed at Heriot-Watt University since 1981. The St. Venant equation of motion and continuity may be solved by procedures based on the method of characteristics and finite differences, suitable relations were developed, validated experimentally and then introduced in the model. They take account of steep fronted waves, unsteady flow in vertical stacks, solids transport, changes from sub to supercritical flows in the vicinity of pipe junctions, reverse flow and full bore flow.

A mathematical model HWUNET incorporates these facilities and analyses the local flow depths and velocities within a multi-pipe multi-storey, building drainage network. In addition to the complete specification of the drainage system, the input data to be specified by the user include the pattern and profile of appliance discharges. The figure illustrates the result of a typical flow analysis in a drain collecting the discharge from two vertical stacks each connected to six bathrooms.

HWUNET has been used to design the layout and sizes of building drainage systems, to investigate the effects of design changes by sensitivity analysis and to assess the implication of proposals for water conservation. It has particular application to the design of large or non-standard drainage system, and those with concentrated usage patterns. The benefits of its use have included, for example, a safe increase in design flow loading, the calculation of self cleansing velocities, an indication of the sites of potential solid deposition, and a reduction in vent pipe sizes. It has been found that the number of dwellings which can be connected satisfactorily to a 100 mm drain can increase substantially - in some cases nearly doubling. Use of the method will aid development of standards and legislation.

Contact Prof. J.A. Swaffield, Heriot-Watt University, Edinburg U.K. for further information.

All pipes at 0.02 slope

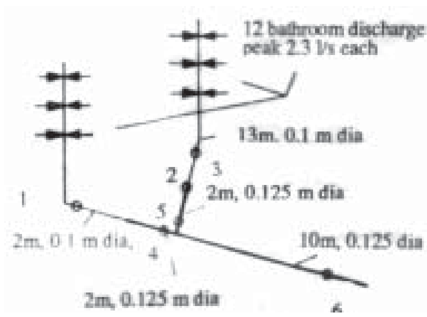

Figure 1: Part of Drainage System

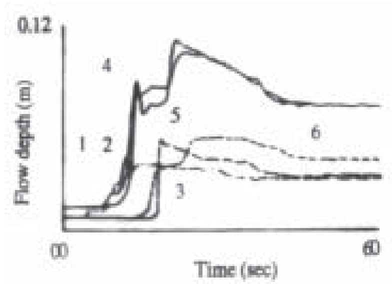

Figure 2: Result of HWUNET use

LANDSLIDE HAZARDS IN NEPAL – CAUSES AND ASSESSMENT

Amod M Dikshit

(Every monsoon, the mountains of Nepal reverberates as large chunks of landmass capitulate and slide due to gravity. Occurring randomly both spatially and time wise, the phenomenon leaves a trail of destructions as the mass moves from a micro watershed into the river basin and finally out of it. The availability of higher mass increases sedimentation rates. Water development projects particularly become vulnerable. This article discusses the mechanism and the causes of landslide with reference to Nepalese hills. It attempts to classify the country into different ground failure prone zones. The best way of combating this calamity, according to the author, is being in a state of preparedness to face the calamity. This entails first, systematically collecting and updating information on landslide occurring over the country. Judicious use of the information can substantially mitigate the losses, while providing a basis for formulating practical accounting methodology. Editor.)

INTRODUCTION

Nepalese people in the hills live with '*Pahiro*' the local term for landslide. Every rainy season people watch helplessly as their terraced fields slump into the rivers or get covered by landslide debris. There is hardly any community in the hills which has not had at least one person killed or maimed by landslide in the living memory. In some villages, landslide strikes in a cyclic fashion, leaving one or two decades of quiescence. In other villages, it is a recurrent happening.

While this natural dynamic, part of which is exacerbated by human interference in the fragile environment, continues, people both in the upland and the lowland passively brave the calamity. Scores of infrastructure projects built in the hills and the terai get washed off, and/or are rendered useless. Road corridors are marred by the scars of landslide. Whole reach of a hill side irrigation canal comes down, once water is released into it.

The magnitude of the catastrophe has dwarfed the corrective measures, which in most cases have been the gabion box retaining walls and tree plantations. Effective to some extent, only these measures can be described best as too simple a solution envisaged for a complex problem.

Apart from destroying lives, properties, and farming in the hills, mass wasting disrupts flow in the river channels. As more sediment mass is available to rivers, the sediment yield gets dramatically increased. This change in balance has its influence on the mechanics of flow which extends to the downstream reaches, and affects all water development projects.

Mass wasting, as a sediment source, had received very little attentions in the assessment of the denudation rates of the river basins. In fact, very little theory is available for practical assessment of the process to be included in the design of the projects, as it has mostly been analysed from soil mechanics and geological considerations.[1]

MECHANICS OF LANDSLIDE

Landslide, a form of mass erosion, is the removal of soil mass from the land surface by the action of gravity. It is associated with variety of processes leading to the failure of a slope. The slope could be natural, formed out of rock and soil; a hill side, or artificial; embankments and earth dams. It could also be the combination of both. Whenever these materials move down or outward in a chunk, landslide occurs.

All slope movements, at fist glance appear to be similar. However, there are features distinctive to a particular event, and may be distinguished. Generally, five different types of motion can be observed in landslides. Among these fall, topple, slide and flow form the four types, while the combination of any of these can be considered the fifth. The combinations of slope materials

Table 1
Classification of Landslides[2]

TYPE OF MOVEMENT			TYPE OF MATERIAL		
				ENGINEERING SOILS	
			BEDROCK	Predominantly coarse	Predominantly fine
FALLS			Rock fall	Debris fall	Earth fall
TOPPLES			Rock topple	Debris topple	Earth topple
Slide	Rational	Few Units	Rock slump	Debris slump	Earth slump
			Rock block slide	Debris block slide	Earth block slide
	Translational	Many Units	Rock slide	Debris slide	Earth slide
Lateral spreads			Rock spread	Debris spread	Earth spread
Flows			Rock flow (deep creep)	Debris flow (soil creep)	Earth flow (soil creep)
Complex			Combination of two or more principal types of movement		

and different movements give rise to a variety of mass movements. These may be classified as follows.

Some landslides are large, while the others are small. However, the damage caused by a small one may be more critical than that due to a bigger event. Again, some landslides are rapid, while the others are slow seldom causing injury, but vastly destructive in nature. Some types are common while others are rare.

The behaviour of a landslide, and its impact on man and his surrounding, depends strongly on the type of occurrence. Mitigate measures should therefore, be based on analysis of the causes of the slide. The chances that any proposed measure would be based on wrong hypothesis, that could lead to the failure of the measure, remains very high, if the focus is placed only on the final event.

All type of mass movements mentioned in Table 1 occur in the Nepalese Mountain scope. The most frequent, and the ones that cause greatest destructions, both in terms of loss of lives and properties are the debris slide, debris avalanche, rock fall and slump.

CAUSES OF LANDSLIDE

A slope is acted on by two forces; forces that hold the materials together, and the force that pulls them down e.g. gravity. The slope remains in place, as long as the forces, which hold the materials together, exceed the driving or the pulling force. Whenever, the later overcome landslides. The balance is tipped by complex interaction of different causative factors. These can be broadly categorised as

(a) factors which further increase the driving forces, and

(b) factors that reduce the slope's inherent strength.

Driving forces may be increased by several external influences. Earthquake is the major one, as it gives rise to transitory forces. Vibrations caused by blasting, and traffic movements also add to the driving forces. Excavations of hill-side for roads, canals, and quarries can effectuate increase in the driving forces as the supporting columns are removed. Sudden drawdown in reservoirs can set slope failures of the water face of earth dams, embankments, and natural slopes. Increases in the driving forces may also result from, snow accumulation, talus, road fills and waste piles. Canal water leakage in a hill side slope reduces its stability, and initiates the slide.

Withdrawal of lateral support by riverbank, subsurface and other forms of erosion can also give rise to more driving forces. When underlying supports are removed by shore undercutting quarrying and mining, extra driving forces are generated. Lateral water pressure and its freezing in fissured rocks may also increase the forces.

Reduction in strength of the slope is caused by inherent weakness and the gross structural property of the rocks. Faults, folds and discontinuity planes (joint, bedding, schistosity planes), pore water pressure, changes in physical and chemical reactions, stress relief due to rapid unloading can further reduce the strength.

Table 2
Natural and Anthropogenic Factors of Landslide in Nepal

Natural	Antrophogenic
1. High Relief >75% landslide in mountain slope in range of 36-54^0 > 70% Landlisde occur in slope in range of 40-54^0 Bank undercutting of deep incised rivers	1. Deforestration 2. Improper Landuse cultivation in steep slopes irrigation in steep vulnerabler slope overgrazing quarrying without due consid deration of terain
2. Weak Rocks phyllites, slates, schist with calcareous interlayer that leads to porosity and void formation due to dissolution.	3. Construction Activities lack of terrain capability evalua tion before infrastructure placement in hills roads and canals in unstable and high hazard slopes
3. Complex Geological Process intense faults, nappes and inbricated structures that have led to fracturation of rocks. As many as four sytematic set of fracture plus other random stress relief joints are very common.	unlined canal across a potential or active landslide. road cut in toe of an ancient landslide deposits inadequate maintenance of infrastructures.
4. High Weathering climatrre and prresence of discontinuity planes	
5. Concentrated Rainfall	
6. Seismic Activity reveral active faults mapped.	

All these factors acting in isolation or together are active in the Nepalese hills. The factors can also be gro

uped as natural and anthropogenic; those due to the natural properties and those induced by human activities. These are summarised in Table 2.

LANDSLIDE TRIGGERS

While the complex interaction of the factors discussed above are responsible for landslide, the ultimate event must be triggered by an external agent. The triggers of landslide in Nepal can be identified as:

(a) Rainfall/Cloudburst and
(b) Earthquake

(a) Rainfall / Cloudburst

High intensity rainfall can trigger landslides in many cases. Rainfalls, with more than 40 to 60 mm of rain (and/or hail) falling within one hour trigger debris flow in high sloped ravines, torrent channels, and along unprotected enscarpments of loose deposits.[3] Rainstorms with more than 150 to 200 mm of rainfall in 24 hours and intermittent squalls with 10 to 30 mm of rain per hour can cause soil slip, debris avalanche and embankment slumps.[4]

Majority of the landslides in Nepal occurs in the late monsoon period. Incessant rainfall during this period, when the antecedent moisture content of the land surface reaches a satura-

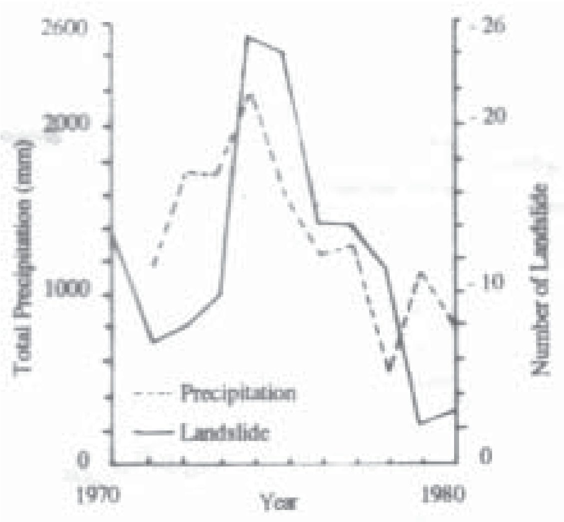

Figure1: Total Rainfall in a Year vs. Landslide

tion stage, is found to be accompanied by landslides. In western Nepal, landslides occur even in the months of January/February as the region receives more average rainfall during this period than rest of the country. This influence of rainfall on slope failure is indicated by the good correlation between the number of landslides and the total rainfall in a year as shown in Figure 1.[5]

Though the actual effect of cloudburst on landslide in the country is yet to be studied specifically, existing evidences suggest that cloudburst could be one of the main trigger of landslides. Widespread occurrences of multiple landslides, within a limited span of space and time, in a rainy day, could as well be triggered by cloudburst. The debris avalanche and debris flow of Dolakha in 1985, and Sindhuli in 1986 can be cited as the examples of mass movements triggered by cloudburst. The en masse hill slope failure near Lele in Lalitpur district, which is documented in one recent publication[6] is a slide triggered by rainfall.

(b) Earthquake

Earthquake has triggered ground failures and landslides in many parts of the country. The 1982 landslide in Bajhang is a case in point. Earthquake triggered slumps, debris slide and rock fall are evident in mountains, while the terai region suffers from lateral spread of soil mass, liquefaction and sand boils due to earth tremors.

There are significant evidences to suggest that landslides, which have occurred in colluvium during the next monsoon, were in fact loosened by previous year's earthquake. Hundreds of landslides of various types were triggered by the 1988 August Udayapur Earthquake, especially within the isoseismals of the epicenter intensity of VIII in Modified Mercalli Scale.[7]

In addition to these two, critical stage of toe undercutting of marginally stable slopes, especially those consisting of older slide deposits, by floods and debris torrents also trigger landslides. Landslides have occurred due to toe undercutting trig-

Table 3
Landslide Indices for Various Ecological Regions

Ecological Region		Natural landslide density	Total landslide index	Land increase index	Natural landslide
Symbol	Name	(N) no/km	(T)no/km	A-T/N	N/T x 100
III.M	Central Mahabharat Lekh	0.88	3.61	4.10	24
II. D	Central Transitional Mountains	1.72	4.12	2.40	42
III. D	Baglung Middle Mountains	0.58	1.39	2.40	42
III. G	Eastern Middle Mountains	0.56	1.26	2.25	44
III. H	Far Eastern Middle Mountains	0.61	0.94	1.54	65
III. F	Kathmandu Middle Mountains	1.00	1.43	1.43	70
II. E	Eastern Transitional Mountains	1.10	1.53	1.39	72
III. P	Far Western Mahabharat Lekh	0.48	0.65	1.35	74
III. E	Central Middle Mountains	0.67	0.84	1.25	80
IV. C	Eastern Siwaliks	1.68	2.02	1.20	83
III K &L	Eastern Mahabharat Lekh	1.64	1.92	1.17	85
III A&B	Far Western Middle Mountains	0.54	0.57	1.06	95
III. C	Pluthan Middle Mountains	0.79	0.82	1.04	96
III. N	Western Mahabharat Lekh	0.72	0.75	1.04	96
Average Middle Mountains		0.65	0.96	1.48	68
Average Mahabharat Lekh		1.02	1.21	1.19	84
Average of All		0.89	1.20	1.35	74

gered by debris current, and floods, that resulted from intense rainfall, within a stretch of Lamosangu Jiri road in Dolakha district[8] and Kathmandu-Kodari Highway in 1987. The resulting slides, extending from the toe of the slope to the road, damaged the highway severing transportation for days.

Breaching of landslide dams in rivers can also be considered as another landslide trigger.

LANDSLIDE ASSESSMENT

If all types and causes of landslide are found in the hills, the next logical question is the extent of landslide hazard afflicting the country and it's assessment. Preliminary assessment of landslide movement in Nepal was undertaken only in 1978 using aerial reconnaissance flights. The results of this study, which is tabulated below shows a high landslide density. Other observations also show landslide density, as high as3 to 4 no/km^2, in the far western districts Bajhang, Darchula, and Baitadi. Similar high density have been observed in Taplejung, Sankhuwasabha, Udaypur, Sindhuli areas of the country. Another report estimates, 12,000 landslides occurring in one single monsoon day in the country.[10]

A recent study showed that the national vernacular daily, the Gorakhapatra, reported 132 cases of landslides during 1970-1980.[11] Other official sources reported 28 significant landslides in nine districts in the 1988 monsoon.[12] Majority of these events, have occurred in the central mid western district - Palpa, Baglung, Kabhrepalanchowk and Singhupalchowk, mostly during the rainy season. Out of the total events, 49 have occurred in August. The average death toll per year according to the study is 78 where as 66 people died in 1988. Fourty households in the hills were destroyed by the slides in the same year. The direct annual economic losses is estimated approximately to be 6.3 million Nepalese Rupees.

This assessment, however, provides only the preliminary order of the losses incurred, and is not representative of the actual loss. This is because, most of the reported cases have occurred in generally accessible regions, and the events were associated with loss of properties and had high death rate. Events in the remote regions of the country and those, without catastrophic tolls are found, not reported.

The estimation also does not include the indirect losses. For example, landslides along road corridors and irrigation canals are not reported, even though the associated losses and the rehabilitation cost can be significant. Similarly, indirect costs due to loss of agricultural and forest land, disturbances to the drainage network, and effects on water resources projects are also not included. The actual occurrence of landslide and the associated losses are therefore much higher. Until the monitoring mechanisms are strengthened, this discrepancy would continue.

The available information, however, can be combined

Figure 2: Geological Hazards; Types and Degrees.

with the geological nature, type of rocks and degrees of slopes of different regions to prepare a mass movement hazard map of the country, Figure 2.[13] It is evident from the map that the mountain regions fall under very high to high landslide hazard categories. High hazard areas of the central and the eastern regions are evident, while the far-western region comes under very high hazard category. This probably is due to the effects of seismic activity, which is characteristic of the region. Many landslides in the region owe their origin to the seismic loading during the earthquake of 1966 and 1980.

CONCLUSION

The physical situation of the country implies that landslide hazards are natural to the region. As uncontrolled interference to create living for the growing population continues, the scene is likely to be aggravated in the future. The problem however, is not uncontrollable. A well-conceived mitigation initiative, is the best way of addressing the problem, associated with landslide hazard.

Experiences of landslide damage reduction in other countries suggest that dramatic results, as high 90 per cent reduction in the damage costs, can be achieved. This has been made possible by first shifting the concept from that of fatalism to being in a state of preparedness to tackle the calamity. Best use of scientific and technological advancement have been made.

Landslide hazard reduction in Nepal needs emphasis on two major areas. The first focus must be on acquisition and management of all information on landslides and mass movements. This must be supported by study and analysis of both the natural and anthropogenic factors of mass wasting, assessment of the degree of hazard and their mapping, and evaluation of the social, political and technological options for forestalling disasters due to landslide.

The approach would enable identification of mass wasting prone areas where measures can be taken to minimise sediment productions. The synthesised information would further permit focus on research initiatives to define the structure of landslide and their role in the river basin. Mass wasting hazard could then be related to requirements of water, and other development projects.

The second package of the programme should concentrate on providing this information to the end users and also ensuring that the information is utilised by both private and public institutions at village, district and regional levels. The information, for example, could be used in planning and designing infrastructure project, development of appropriate land use regulations, codes and legislations, and formulations of management plans for disaster rescue. An integral part of the plan must be inclusion of disaster consciousness in all development programmes. It is only through these measures, landslides hazard in its entirety can be evaluated to evolve environmentally sound development.

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Articles on personal experiences are welcomed

EXPERIENCE OF DEVELOPING RAMGHAT DRINKING WATER SYSTEM.

Thelma Howard.

(*Water supply development in even a small community necessitates constant interaction between the beneficiaries and the implementing agencies at different stages of the project cycle. Water supply improvement programme can not succeed without the support of the community, who have to be continuously convinced, motivated and involved. This article, based on a report submitted by the author, encapsulates her experience of water supply improvement in a community on the bank of Bheri River in mid-West Nepal.* Editor)

The people of Ramghat took time of their daily activities and excavated more than 1.5 km long trench for the pipeline. But when the pipeline was connected to the intake system, water did not flow. People became very unhappy.

Every one though that the problem was with the intake, which was built without the usual intake tank. The new intake, called 'gallery system', was recommended by, and installed under the supervision of the engineering advisor in the Karnali-Bheri Integrated Rural Development Project.

The system was recommended because of its simplicity, and inexpensiveness. It was also suggested because it would not disturb the source and is better protected against floods, compared to an intake tank. The villagers did not understand these new systems, and were not satisfied. Many felt than an intake tank would still be needed, without which the water system would not function. Since the problem was complicated, and beyond the villagers' know-how, a request was made to the district drinking water office to rectify the problem.

The engineer who designed the system could not be contacted, as he was away on project supervision assignment. However, another engineer from the office agreed to stop a Ramghat, while on his way to the project at Gumi, which he was supervising. He felt that the survey may not have been accurate, as the slope appeared insufficient. He suggested that the original designs be carefully checked prior to any changes. Few weeks later, the engineer, who surveyed the systems, rechecked the design and confirmed that the original survey was correct. The problem, he said, was the blockage due to air pockets. The villagers were not convinced. When the engineer along with the overseer came to work on the air blocks, only two villagers came forward to assist.

The problem, actually had been blockage of flow by air pocket formation, and when it was removed, water flowed from the pipe end. The villagers were very apologetic and the next day many came out to help. The reaction of the community, when water finally flowed was of great excitement and relief. It was understandable, because the first discussion, about the need for a water system in the village, had taken place more than three years ago.

The flow however, was less than what had originally been designed to be supplied. The engineer suggested that few modifications and a control valve, would increase the flow and be enough to meet all the taps in the system, which were six in numbers. After discussing with the concerned district development officials, extra pipe and fittings were sent to Ramghat. The new water system was modified under the supervision of the overseer. As predicted, the flow increased. This main line has not yet been connected to the tap stands, as the villagers were not able to participate in the activity due to harvest time, which was more important.

The increased flow has enabled the people to water their kitchen garden. In fact, water was already stored in a pond that was excavated by the villagers a year earlier. A member of the community, who lived beside had dug a ditch and was watering seedlings in his kitchen garden. He was extremely pleased, that he now had access to water. Women were also taking cows and buffaloes to the pond.

A minor conflict however, developed between two wards of the village. People of ward no 3, where this water system was developed, were reluctant to provide a connection from the system to a school in ward number 2. "These people did not co-operate with digging of the trench, moreover another source in that ward could be tapped" members of ward number 3 argued. It was then mentioned to the villagers that schools was a public institution and that even their children attended the school. Since water was adequate, additional tap could be easily accommodated, it was further mentioned.

The situation still remained to be resolved. Further contact with the villagers, and convincing them would be needed to tackle the situation. Co-operation would be needed of both the wards, to clarify the status. It needs to be explained to them that any new system can be built only after its feasibility study, that people of ward number 2 also have obligations to participate in the development of the water system.

BOOK INTRODUCTION

IRRIGATION REQUIREMENTS AND ITS SCHEDULING FOR DIFFERENT AGRO-CLIMATIC REGIONS OF NEPAL TERAI

Author : Mahesh Man Shrestha
Publisher : Department f Agriculture, Ministry of Food and Agriculture, HMG, 1980, Kathmandu, Nepal.
Chapters : Major Headings include Introduction Potential Evapo-transpiration, Irrigation Efficiency Irrigation Scheduling,
Annex drawings: 12
Pages : 108
Reference : 23
Price : Not mentioned.

Irrigation development is simply getting water to the command area through the array of controls. It is more of a judicious application of this water to suit the land and crop. Accurate estimation of the water, needed for different crops and water scheduling, permits application of as much water as needed from the basis of scientific in-farm management. It also provides the estimation of the actual water needed for planning new irrigation systems.

This book, according to the author is an attempt to estimate water requirement of crops at different agro-climatic regions of Nepal terai -–the plain area in the south. Available climatological data have been fitted into Hargreaves method of estimating consumptive water use of crops. The procedure according to the author, can be used to estimate water requirement for short periods at farm or project levels.

Rainfall generally satisfies the potential evapo-transpiration during the monsoon months, while the soil in the remaining months needs water for better yields. Application of irrigation water however, should consider other factors like agricultural inputs, type of crops, soil type and efficient water use. Although, no data to show the influence of groundwater table in irrigation water requirement is available, the author observes that in certain areas like Bhairahawa, where ground water is about 1 m below, one or two water application at crown root during initial and flowering stages may only be needed for optimum production of wheat. Studies I India have shown that in areas having high water table, one irrigation water application of 75 mm, three weeks after sowing was found to be adequate for attaining maximum crop yield of wheat. Additional or excess water instead of increasing yield, creates wastages that ultimately lead to salinity and water logging.

An irrigation scheduling procedure has been developed for specific crops like wheat, corn, cotton, sugarcane and paddy (main). Prediction of irrigation water needs in advance is suggested for the planning other farming activities, and scheduling of the required irrigation water, when the capacity of the system or the allotted flow is limited. The approach which is supported by field observations, is recommended for management of modern irrigation farm in Nepal.

This book, though published earlier, can be a valuable contribution to the area e.g. irrigation water management, which undoubtedly needs more focus in years to come.

TOKYO DECLARATION ON THE INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION

(Adopted by the International Ad-Hoc Group of Experts)

(UN Secretary General appointed an International Ad-Hoc Group of experts, composed of representatives of various scientific and technical disciplines pertaining to disaster prevention and mitigation, to help him to develop a framework and specifically to identify priority areas for application of existing knowledges, to identify gaps in existing knowledge, and to provide recommendations concerning matters of implementations, in connection with the declaration of 1990s as the International Decade for Natural Disaster Reduction. The declaration which was made on 11th April 1989, is reproduced below Editor)

Throughout history, mankind has lived under the threat of natural disasters. Millions of lives have been lost in recent decades, with untold human suffering and property damage as well as setbacks to development efforts. Indeed, the situation is growing worse. Vulnerability to natural disaster is rising due to population growth, urbanisation and the concentration of industry and infrastructure in disaster-prone areas. But we now have improved capacity to confront the problem. Fatalism is not longer acceptable; it is time to bring the full force of scientific and technological advancement to reduce the human tragedy and economic loss of natural disasters.

This concept is the premise of the United Nations General Assembly decision, in its resolution 42/169 of 11 December 1987, to designate the 1990s as an International. Decade in which the world community joins to co-operate on natural disaster reduction.

The Secretary-General of the United Nations, who was asked to develop a framework to attain the objective and goals of the Decade, appointed our committee, the International Ad-Hoc Group of Experts. We are 25 scientists and technical experts drawn from throughout the world and representing the spectrum of disciplines engaged in disaster reduction. We will soon submit our report to the Secretary-General, but today we wish to call to the world's attention our common conviction that millions of lives can be saved, hundreds of millions protected from tragedy, and hundreds of billions of dollars saved as a result of the International Decade.

Since our first meeting at Geneva in July 1988, there have been floods in the Sudan and Bangladesh, hurricanes Gilbert and Joan in the Carribean and Central America, destructive earthquakes in China, India, Nepal and the USSR, and severe drought and locust infestations in Africa. The post-disaster response of the internatonal community has been generous. But observing these and other tragic events has convinced us of the need for increased efforts in disaster planning, preparedness, and prevention.

We believe that the Decade is a moral imperative. It is the first co-ordinated effort to prevent the unnecessary loss of life from natural hazards. It also makes practical sense. The Decade is an opportunity for the world community, in a spirit of global co-operation, to use the considerable existing scientific and technical knowledge to alleviate human suffering and enhance economic security. In implementing the Decade, the vulnerability of developing countries must be of special concern. Thus we, the International Ad-Hoc Group of Experts call upon:

The people of the world as well as their Governments, to work toward greater security against natural disasters;

The Government of all countries to participate actively in the Decade by educating and training their citizens to increase awareness, by enhancing social preparedness, by integrating disaster-consciousness into their development programmes, and by making available the power of science and technology to reduce disaster loss:

The United nations, scientific and technological institutions, non-governmental organisations, and the private sector to support international and regional co-operation on disaster-related activities and to contribute to the transfer of disaster-reduction technology, particularly in disaster-prone developing countries.

The Decade is an opportunity for action, both immediate and long-term. Specific projects can be implemented immediately to help achieve a safer world. Implementation of the Decade requires commitment of the international community to enhance the level of technical co-ordinate national efforts. It suggests that the United Nations General Assembly consider the establishment of a unique co-operative mechanism, supported by extra-budgetary resources, that brings together the diverse groups that can contribute to the Decade. It seeks the commitment of the international community to assure the availability of resources to implement this important activity.

The group is confident that, through these actions, mankind will capture the promise of enhanced security and prosperity.

VIEWS FROM READERS

I finally managed to clear my desk enough to uncover and dig into the last couple of issues of Water Nepal. Reading Water Nepal brought to mind some recurring themes that I have been formulating and refining in my own approach to the larger question of development work. I find myself just as caught and directed by my own background in human resource development as I will shortly lament about other professions involved in development we all tend to look at the problems and approaches, through the eyes of our own professions.

During the Carter Administration in the United States, President Carter was criticised by the press in the United States for authorising the disastrous attempt to rescue the American diplomatic hostages held by Iran. When asked why he had chosen to use the military in that situation, he said that he was following the advice of the military experts that he brought in to consult with on the crisis. A reporter pointedly asked, "Didn't you realise that by bringing in the military as consultants, you were already limiting your solutions to military ones?"

May be the analogy only fits imperfectly, but aren't we in development work all too often guilty of the same error – defining the problem by narrowly limiting the solutions? How often do we, when confronted with a village's need for water, start thinking in terms of immediately bringing in water engineers as consultants instead of taking the time to clearly define the entire interactive system operant in the village, including local society, customs, agricultural practices, power structures, and the myriad other factors involved?

My own profession prejudices me to think in terms of human solution to these problems. In providing training for those workers, whose technical professions and skills will be ultimately called upon of micro-level development solutions, it seems clear to me that there is a need to train, for example, water engineers not just in the plain and simple knowledge and skill competencies necessary for putting in a water system, but also in the seemingly ethereal competencies that have to do with attitude. If engineers can be trained to see the situation, as well as its possible approaches and solutions, through the eyes of various village end-users, I believe that the likelihood of success and sustainability of the project will be increased.

The difficulty in this approach to training is that it is hard to un-train engineers (and other professionals, to be sure) in the very approaches and methodologies that academic institutions attempt to instill. Water development is not merely a series of careful surveys, precise calculations, and quality pipe fittings. It requires more than occasional forays into the realms of the emotional, the political, the illogical, and the mood and aspirations of the community of end users.

None the less, it is this shedding of our professional approaches that will allow the light of perspective and understanding to shine on our attempts at development. I encourage the readership of Water Nepal to look at development, and the training of development workers, regardless of their professions and areas of expertise, in these terms.

Ray S Leki
Training Officer
Peace Corps/Nepal.

Mr Colin Glennie's article 'Latrine- Time for New Approach' reprinted in Water Nepal Vol 1, No 3 July 1989, is an excellent proposition of how sanitation promotion should be pursued in developing countries. His SANITATION TECHNOLOGY SUPERMARKET approach !; letting people decide on the sanitation method, can be also applicable in Nepal, where efforts are being made to improve peoples' health by implementing water supply and sanitation programmes.

The influence of peoples' sanitary perception while selecting the method they prefer, was evident in Daletar, a village in Chitwan district, where in August 1989, I attended a workshop on hygiene education. The workshop focussed on how to involve the community in determining their hygiene needs, then develop and implement hygiene education programme.

A gravity flow water system, utilising a spring water source had been completed in the village a year earlier by the ministry. We spent two days in the community obtaining information from the villagers on their hygiene needs. The priority for latrines was found to be very low on the villagers' agenda on hygiene education. They rated practices such as regular bathing, washing clothes and utensils higher than construction and use of latrines.

Sanitation Promotion Campaign involving latrine construction will be effective when the genuine hygiene priority of the people are incorporated in the promotional programmes. The programmes will succeed, if latrine uses are preceded and complemented by safe use of water and general environmental improvement of the household. An intense motivation programme would be needed to persuade the people to accept benefits of latrine in improving their health and hygiene.

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THELIMA HOWARD is a sociologist, and was associated with the Karnali Bheri Integrated Rural Development Project in mid-western Nepal, where she served as a community development advisor for two years. She us now in Canada,where she continues her interest in third world community development.

JOHN A SWAFFIELD, whose research report is reproduced in this issue, is professor at Heriot-Watt University, Edinburg UK. Professor Swaffield has been developing improved computer based methods of analysis of unsteady part-full pipe flow since 1981, and has collaborated with the National Bureau of Standard, Washington USA.

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