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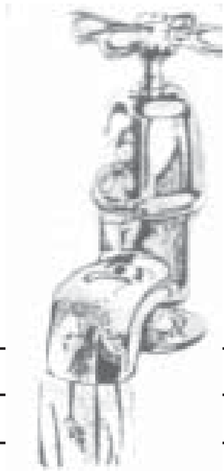
WATER NEPAL



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WATER DEVELOPMENT BULLETIN

TREES CONSERVE WATER

SAVE FOREST
PLANT TREES

IN THIS ISSUE

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.

Views expressed in this publication are that of the writters 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 from the readers. 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 Unpublished articles will not be returned.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 article and letter will lie on the editor.

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A DROP NOT WASTED IS A DROP SAVED
WATER IS LIFE. CONSERVE WATER

EDITORIAL

Ever since their formation water has been flowing for millenia from the himalayas, bringing life to south Asia. For long, this water wealth remained unused as our forefathers lagged behind in harnessing its potentials for improving their quality of life. Nepal remained in complete isolation, while industrial revolution in Europe was heralding ways of bettering living conditions. The strides made in the development of science and technology skipped many Nepali generations. Educational development, attitudinal changes and prosperity did not come about for a long time. Only the historic changes in 1951, ushered in a new beginning to solve the problems brought about by prolonged period of neglect and obscurity.

Not that water remained unutilised for beneficial purposes. Indigenous systems have been irrigating field since the early days, and more areas has been brought under irrigation lately. But agriculture in the past remained at subsistence level, and at recent times productivity has not matched the growing needs. And although, the first hydropower project in the country was built more than seventy-five years ago, today at the turn of the century, only a small fraction of the available potential remains produced. For a country facing severe economic problems, the abundance of water and its apocalyptic underutilisation appeared paradoxial.

Studies carried out so far indicate that relatively cheap power could be tapped from sites in Nepali rivers, with regulated flow as a by- product for meeting irrigation requirements and flood control measures. These by-products apart from meeting domestic water needs have the potential of benefiting the region also. The prospects of diversification and rejuvenation of the country's economy, through these inputs appear very attractive indeed. But, a number of questions need to be answered before such predictions can be made.

Does availability of power, automatically ensure industrial development without provisions of supporting resources and market? Or is building irrigation systems a guarantee for increased productions in absence of agricultural inputs? Our experiences in the past decades provide best answer to these questions and should be taken into account in formulating future development programmes. The contribution of water as a catalyst for development will be evidenced only in the distance future than on a foreseeable one. In order to sustain the economic benefits all current inputs made in water development must be sound and appropriate.

This very notion brings us to a collision course with the challenges that have to be tackled. The challenges are imposed by among others, the physiography of the country, the applicability and selection of technology, and the implications arising out of the social structure. The region with the extremities of geology, seismicity, climate etcetra pose difficulties in constructing hydraulic structures. The difficulties also emanate from the fact that relationship between interacting physical processes have yet be explained fully. Many traditional theories of water conveyance, sediment transport and hydrology may not be relied upon totally in the hilly tracts. Their applicability needs to be validated, and suitably modified. Though answers to many of these problems may be found in the technological shelves of the developed countries, an inherent danger lies in such a parasitic approach. Also the choice of technology should be relevant to the country's scientific temper and the ability to address al related matters.

The social structure, being as it is brings in additional implications. The varying level of modernity in our urban areas compared to the object backwardness in the villages and rural areas is one manifestation of the impliations. Since one set of social norm does not exist, no specific development model will be applicable. The risks of concentrating on only the needs of the villages at the cost of modern technology or vice-versa can have serious repurcussion. This duality hence necessitates a balanced approach to fulfill the needs of the village while taking fullest advantages of the opportunities offered by modern technologial development. Modernity, however, should not always have technnological answers. The need for innovative and indigenous solutions to the problems of development, especially in water utilization remain all the more important.

In this issue, we have attempted to focus on some of the diverse areas. Basic sanitation and water supply at community levels are looked at, on one hand, while on the other specialised areas like energy storage in aquifers and erosion in hydraulic structures are discussed. These articles represent the type of problems faced in water development endeavors.

Various factors working in tandem have relagated us to the lowest rung of the economic ladder. The answers to our problems lie in not succumbing to the effects of these factors, but on proving ourselves as a hard working people capable of taking great social and economic strides. Let the experiences we have gathered so far in water development be a ray of hope and stepping stone for Nepal's development.

LATRINE – TIME FOR NEW APPROACH

Colin Glennie

(Reproduced from Adab News, a bi-monthly journal of the Association of Development Agencies in Bangladesh Vol XV No. 2 March/April 1988).

Having been in the "latrine business" for several years, I have been privileged to inspect quire a few latrines! I often used to try and think of the best latrine I have ever seen. Until recently, it was a difficult choice. But about six months ago, I saw may best Latrine. You may be surprised when I describe it to you. It consisted of two damaged clay pots, formerly water pots, which had been buried in the ground – one on the top of the other. There was a hole in the bottom of the upper pot opening into the lower pot. The neck of the upper pot protruded about 75mm (3) above the ground to from the opening of the latrine. This opening was covered with a small clay "saucer" which was removed during use. Only excreta entered the latrine, while urine was discharged on the ground and channelled away. The latrine was almost full, yet there was no smell and no flies. It was situated just behind the house and the existing boundary of the bari gave enough privacy so that a separate super structure was not necessary. The latrine was used by three women, one of whom had the idea and built it herself. It had been in use for about one year. it had cost nothing more than their own labour to dig the hole and the use of the couple of "useless" old water pots which had been lying around the compound.

You will surely ask why I should choose this as the best latrine I have seen. It is not one of the standard latrines that we in our superior wisdom as aid agencies have chosen to give or sell to villagers. What is so special about it?

Before I answer that questions, let us decide what is the purpose of a latrine. From our point of view, as development agencies, surely the only essential function of the latrine s to remove excreta from the environment. The users, however, give more importance to privacy and convenience. For them, the ideal latrine is the one which people cannot see you using and is just far enough away for the smell and the flies not to be a nuisance in and around the house. And we all agree that the latrine must be affordable. Of course there are other desirable features of a latrine, both from our point of view and that of the users, but the above four features are certainly the most fundamental ones, and the rest are only subordinate details.

So what is so special about the water jar latrine? Well, all the latrines I have seen fill into one of the two categories – those that are designed by us for them, and those that they design for themselves. The ones in the first category tend to meet our requirement, but, although we think they are cheap, they are usually at a price that is beyond the capacity of the majority of householders. The ones in the second category generally do not isolate excreta, but do satisfy the users' requirement for privacy and convenience and at a price which they can genuinely afford. The special feature of the water jar latrine is that is was designed by the users and it satisfied all the four fundamental requirements, namely, excreta isolation privacy, convenience and affordability.

The lesson of this is not that the UNICEF has now found the perfect latrine. We are not about to start telling everyone to build latrines out of old water jars! Just the opposite! I d raw two lessons. First, we should stop promoting sanitation exclusively on the basis of health benefit. Instead we should emphasize the privacy and convenience of a latrine as well as the health benefit of isolation of excreta. Secondly, we should stop pushing any particular technology as if it is the only answer. Instead, we should suggest a wide range of latrines, from the very simplest for the poorest villagers up to most sophisticated for the richest.

The criteria for the type of latrines to be suggested (technology is too grand a word) is that they must all satisfy the four fundamental requirements and they must all use materials that are available or easily obtainable locally in village environment. Of course, all latrines will have both advantages and disadvantages. The water jar latrine is a good example – it is extremely cheap (almost every household is likely to have broken pots lying around), very easy to install and is unlikely to collapse. But of course, it has a limited capacity. This means that either a new latrine will have to be built every year, or that two or be built every year, or that two or three such latrine will be needed by one household. But even this disadvantage can be turned to advantage. People often prefer to have separate latrines for men and women, and it is so cheap and easy that it is quite feasible even no build additional latrines for children and adults.

What can be used to line the pit? Well, anything that is used for storage above ground can also be used for storage below ground. For example, one can use large storage baskets made of bamboo or cane as used for storing grain; large clay storage pots (now-a-days less common but still used in some areas); tarja[2] sheets (as used to wall kutcha[3] house) can be rolled into a cylinder, old 44-gallon drums of oil or bitumen etc.

What can be used to cover the pit? The beauty of the water jar latrine is that there us no large diameter hole that needs to be covered. But most pit latrines need some sort of cover which must be strong enough to take the weight of the user. Bamboo can be used, of course, provided the size is right. But branches, wooden planks, an upturned gamla[4] or chari[5] as commonly used to put cattle feed and to parboil rice, would have to be specially adapted at the time of manufacture to include a squatting hole and, perhaps, footrests. And of course, at the upper end of the scale there are the concrete and clay rings and the concrete or ferrocement slabs with an d without water seal pans that the Government and most development agencies promote.

Not one of these latrines is the perfect answer. And all of them require care and attention to important details when they are being constructed. We know that bamboo or tarja pit lining will not last very long – may be only a year or two, depending on its quality and whether it is treated with preservative. So there is no point in digging a deep pit that will take four years to fill up as it will probably collapse before then. So if the pit lining is liable to rot, the pit should not be too deep – say shallow enough, it may not even need a lining, but then of course, it will fill quickly. Bamboo used to cover the pit will also rot especially if the bamboo is only finger thick, but then the correctly thick bamboo will cost more. Every latrine material has its advantages and disadvantages – usually cheaper the material the shorter the life.

But then the same could be said of material of house building. Who has ever designed the perfect house? We often forget that most of the people we are trying to help live in kutcha houses which they build out of locally available materials. As far as possible, they avoid having to buy anything. The result is not perfect. It leaks in the monsoon may fill down in the nor' wester storms and gets damaged by flooding. Every year, it requires some maintenance and repair. Yet, there is no project that tells people exactly what type of house to build, or sells them subsidised material to build it (except for a few resettlement schemes). Even the poorest villager somehow manages to make some sort of shelter without any help. The reason is that people know they need a house and have been building their own houses for generations, and they don't need to be told now to do it. Yet when it comes to sanitation, we think we know what is best for them. We have chosen a pukka concrete rings for a environment where the use of concrete is a rare and expensive luxury. We have is "low cost", but which may cost more than many villagers are able to spend on building a house (the DPHE latrine cost Tk 250, but by the time it has been transported and installed and the superstructure build, it will cost a total of Tk 500 to Tk 1,000). So it is not surprising that only the better off villagers are buying this type of latrine, while the majority of people are offered no choice, but to continue random defecation or use unsanitary open latrines.

This is why we now need to adopt a new approach to latrine. We know there are a significant number of villagers who are interested in some type of latrine, - some 30 percent are already using a fixed place for defection. Our approach should be to encourage them to upgrade their current latrine "technology" to include isolation f excreta, and as far as possible, leave them to decide how to do it. Of course, we can help them process a bit by showing how some people have already done it and by suggesting other ways - but the basic approach should be "let the people decide".

You may ask, "What about our water-seal latrine?" Well, of course, this still has a very important role to play. The UNICEF is proud to have made a major contribution to the promotion and popularization of this type of latrine. It is certainly the best low-cost latrine in terms of technology and will continue to be the choice of the majority of people who can afford it. The trouble is that we have been almost too successful in promoting it so that it has come to be assumed as the only acceptable latrine both in the eyes of the villagers and of the Government and development agencies. The UNICEF will continue to support this type of latrine, but no longer as if it is the only answer. We would like to see centres which sell water-seal latrine, also demonstrate, and even sell, some of the lower cost options for those disappointed villagers who find that they cannot afford the water seal. At the suggestion of the UNICEF, and Government has recently liberalized its selling policy so that a buyer need no longer buy a full set of 5 rings with one slab; he or she may now buy a slab only for Tk 50, or with one ring for an additional Tk 20; the remaining rings cost Tk 45 each; so the complete set still cost Tk 250. For mere Tk 50, a villager can now buy the most important single component of a pit latrine – a strong slab to cover the pit, with the extra advantage of a water-seal pan. Many will find this the cheapest and best option, but because of a shortage of supply and because the vast majority of people live far away from a source of slabs, not everyone will be able to buy one. It is, therefore, imperative to increase the supply of these slabs – a challenge for NGOs and the Government like.

Some readers may remember the pit latrines made entirely of local materials promoted in the 1970s by the NGO, International Voluntary Service (IVS). If this was the right answer why hasn't it caught on? I think there are two reasons. First and foremost, this was also a "single technology" approach – the agency decided what type of latrine was best for the people. Secondly, the pits were too deep, and the bamboo "slabs" invariably too flimsy, resulting in premature collapse. Thirdly, it was introduced in the early days of sanitation promotion, when people were far less aware than they are now and when demand was very limited. Furthermore development workers today have the advantage of being able to learn from the successes and mistakes of the past.

So, once again, "let the people decide". Our role is only to help them to appreciate the advantage if isolation of excreta while at the same time promoting latrines as the answer to the problems of privacy and convenience; to make them aware of the options open to them; to remind them that building a latrine needs the same common sense as building a house; to help them avoid some of the more common mistake such as digging the pit too deep or to wide, using flimsy bamboo for the slab, not giving enough slope to the roof, etc; to suggest to them a few ideas for using and adapting materials and artefacts commonly found in the village environment; to help to establish production in the private sector of useful component for latrine construction, not only water seal slabs and rings but also, for example, adapted clay artefacts for its covers (e.g., charis) and for pit lining (e.g., rings, pots, jars) prefabricated tarja sheets for pit lining or superstructures (coated with alkatra for longer life at small extra price.)

The UNICEF will be very happy to learn from the experiences of NGOs, and any NGO wishing to pursue this new approach is welcome to contact the UNICEF for discussion, ideas and support. NGOs have always been in the fore front of development in Bangladesh. Instead of our single technology approach to sanitation, let us adopt the new SUPERMARKET approach! This is the only hope of Bangladesh achieving sanitation for all in the foreseeable future.

1. A hut, house
2. An object made of bamboo to enclose with
3. Made of mud, not brick lined
4. A kind of bowl
5. A kind of bowl made of mud
6. Brick-built

The last issue of Water Nepal was brought out in February 1988 and since then because of certain unavoidable circumstances further issues could not be published. We apologise for this delay. We now hope to keep the continuity of this publication in a regular manner.

GROUND WATER FOR THERMAL ENERGY STORAGE

Rabindra N. Bhattarai

INTRODUCTION

Ground water in aquifers can be used as natural source or sink of thermal energy. Thermal energy in large quantities can be stored in aquifers, for retrieval on a seasonal basis, which can be utilised for large-scale air conditioning (heating and cooling) application.

AQUIFER

An aquifer is a geological formation, which contains water and transmits it from one point to another in quantities sufficient to permit its extraction at useful rates. Aquifers are classified into two types as confined. Confined aquifers occur where groundwater is confined under pressure greater then atmospheric by overlaying and underlying relatively impermeable strata. Figure 1 shows the section through the idealised confined and aquifer.

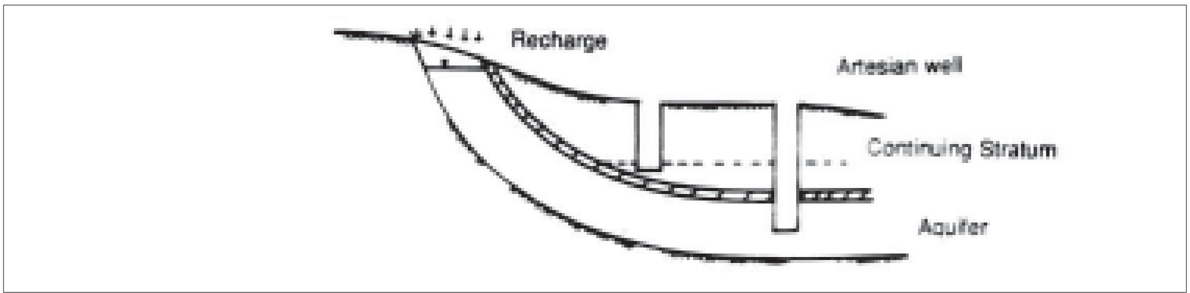

Fig. 1: Idealised Aquifer

Flow of water in an aquifer can be described by Darcy's Law, which is expressed as

$$Q = KA\ dh/dL \qquad 1)$$

where Q = flow rate, dh/dL = hydraulic gradient, A = cross sectional area, K = coefficient of permeability. It is evident from the above equation that the coefficient K has a dimension of velocity i.e. L/T and can be expressed in variety of units. The laboratory (or Standard) coefficient of permeability Ks is defined as the flow of water at 60 F in gallons per day through a medium having a cross sectional area of 1 ft^2 under unit hydraulic gradient.

The relationship between laboratory coefficient of permeability and the associated aquifer characteristics as modified by Schaetzle *et al.,* after Todd is shown in Table 1.

Table - 1
Relation between Laboratory Coefficient of Permeability and Aquifer Flow Characteristic

Aquifer Type	Clean Gravel	Clean sands; Mixture of clean sands and gravels; limestone, dolomite and certain ingeous rocks.	Very fine sands; silts mixture of sand, silts and clay glacial till stratified clays' etc. Sand-stones and carbonates with low porosity and permeability	Unweathered clays; certain igneous and metamorphic rocks
Flow Characterstics		Good Aquifers	Poor Aquifers	Imperious

10^6 10^5 10^4 10^3 10^2 10^1 10^{-1} 10^{-2} 10^{-3} 10^{-4}

Reader, Department of Mechanical Engineering, Institute of Engineering, Kathmandu

THERMAL STORAGE

Thermal storage in an aquifer is a function of rock type and porosity. An aquifer suitable for thermal storage should allow water recovery at the rate of at least one-gallon per minute per ft. of thickness. Porosity of the rock can range from five per cent to more than 30 per cent. However, it usually ranges from 10 to 20 per cent for most aquifers. Most rocks have specific gravity of about 2.6 and a specific heat of about 0.2 Btu/lb-^{0}F. The thermal storage capacity for a degree temperature change is about 30 Btu/ft^3 and varies with porosity. A storage system of dimension 200-ft by 200 ft by 50 ft for example, has a storage capacity of 3.6 x10^9 Btu with 60 F difference in temperature.

The equation for thermal, has a storage capacity per unit volume of aquifer per degree temperature change given by Schnitsel is:

$$q = c\ pr\ þr\ (1-ø) + cpw\ pø \qquad (2)$$

Where q = specific thermal storage capacity in Btu/ft^3 c_{pr} c_{pw} = specific heat of rock and water in Btu/1b^{0}F, p^r, p_w = rock and water density in 1b/ft ^{3},ø = aquifer porosity

$$E = V\ qt \qquad (3)$$

Where E = thermal energy, V = volume, t = temperature difference

$$Vd = \qquad (4)$$

Where Vd = design volume, Va = annual strong, h = system efficiency, t = temperature difference

PAIRED WELL THERMAL ENERGY INPUT AND OUTPUT SYSTEM

Figure 2 shows a pair of well constructed in the aquifer. A normal procedure for thermal storage and retrieval consists of the following processes:

Water is pumped out of one well and is heated, by a low-grade source of heat or cooled depending on requirements. Water is then injected into another well. At the end of the cycle, one well will be warm/cold. During the utilisation cycle, the warm/cold water is then pumped back into the first well. A movement of water and temperature front starts between

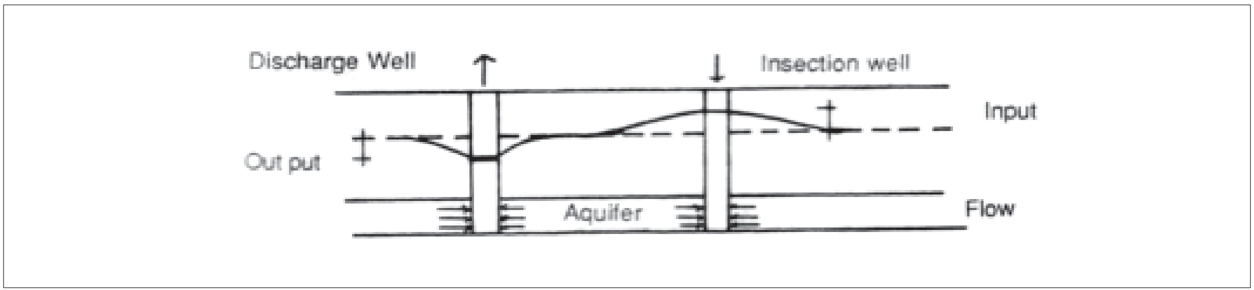

Fig. 2: Paired Well System

the wells, during the process.

In order to determine the velocity of temperature front two assumptions are made. First, the water and rock temperatures at any location in the aquifer are assumed to be identical. The assumption is valid for the large contact area between the water and the rock which is true when flow channels are numerous and very small. Second, the thermal conductivity through aquifers is very small or negligible. This assumption is supported by the fact that relatively small temperature change takes place underground. Based on these assumptions, a temperature front follows the injected waterfront through the aquifer as a step function. This means the temperature wave process is reversed when the water is withdrawn. As a result, the energy stored in the aquifer is retrieved at almost the same temperature as when injected. In other words, water injected at say 80° C will, theoretically, be retrieved at 80^0C.

In an aquifer, the temperature front velocity Vt. is given by.

$$Vt. = \frac{p_w c_{pw} .... V_w}{p_w c_{pw} .... + p_r c_{pr} (1-...)} \quad (5)$$

Where þ = density cp specific heat and Ø = aquifer probity

$$t_t = \frac{p_w c_{pw}. + p_r c_{pr} (1-...)}{p_w c_{pw} ....} t_W \quad (6)$$

The time required for the temperature wave to move between the wells t_t is given by :
where t_t is the time required for the water to move between the two wells

In actual practices, there will be some energy loss. It is a function of surface area per unit volume, the conductivity and temperature of adjacent volume. For most aquifers, the conductivity of the surrounding mass is usually small, the surface area per unit volume is also relatively small and adjacent volume temperature will close to the storage temperature after a few annual cycles. As such, the recovery is high, over 80 per cent. Measurements at university of Alabama, USA have detected less than 0.5º F temperature changes at depth of 8, feet below the surface over an extended period.

USE OF SYSTEM

This system is very useful for heating/cooling of a large commercial complex, or a district. The system utilises low-grade energy such as solar energy or waste heat. The cooling for the storage of cold water can be done during the cold season, and time using suitable cooling towers. The system is pollution free and as the water volume drawn from the aquifer and injected into it is same, the net consumption of ground water is zero. Extensive laboratory and computer model tests of aquifer energy storage system have been done in the United States. This type of system has already been incorporated in cooling/heating of shopping malls.

The primary requirement for the design of aquifer heating/cooling storage system is the ground water data. The prospects of use and design of aquifer heating/cooling system is not possible without reliable hydrological informations. The feasibility of such a system in Nepal can be ascertained only after detailed a survey of the ground water position of the area concerned is carried out. Yet, the system has potential of meeting heating/cooling needs of large building complexes in Nepal.

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Consultant and activist in the field of rural and agricultural development of Nepal

SELF HELP WATER SUPPLY SYSTEM

Hatu Ram Vaidya

In 1981, a rural family welfare project of Family Planning Association Nepal (FPAN) at Heguwapati, Mahadevsthan Panchayat in Kavre Palanchowk District proposed to establish a fodder tree nursery in about five ropanis of land donated by the community. This nursery had to be established by the end of January 1982 so that 30,000 seedling could be produced by the June of the same year.

To design the nursery and complete construction of the terraces within 15 to 20 days became a challenging project for me. The terrace had an average slope of 15 per cent. It had red soil (laterite) which was very hard to dig when dry and easy to work when wet. The establishment of the nursery also required provision for irrigating the sapling.

In order to complete the terrace and provide water for irrigation, the resources available at my disposal were (a) local volunteers for all kinds of earth / labour work to the extent I needed (b) a spring located about 1000 meters away as the only water source and (c) enough fund to purchase necessary plumbing materials and pipes (PVC/HD). Since the time was very short, I decided to do away with any kind

The wood Intake

of cement work to develop the intake and designed a sale wood intake (photograph). The cost of wood, plumbing outfit attached to the intake, plumber and carpenter's charges all total did not exceed Rs 750 in 1981 January. It was assembled in less than a week at Kathmandu.

This wooden intake was transported to the site and was installed at the source within three/four hours with the help of two villagers besides me. While this small crew (of three people) was busy at the source, about 15 volunteers were busy in digging a 1000-metre-long trench to lay the pipe.

The pipe lying was completed by the end of the day and water started flowing at the nursery with plenty of overflow at the intake. Wetting of the soil started the next day and the terraces were completed much ahead of the scheduled time. There was some leakage in the intake, which was sealed by Kalimati (Black Soil). Since there was enough water at the source, full potential of the system was development to irrigate the nursery besides providing a public tap at the nursery gate.

About two years later, the local people were ready to invest their own money to further develop the source and construct an underground cement water tank. The supply line was connected to the underground tank without changing the layout by simple hooking the pipe to the cement tank from the wooden dam. It was easy.

This wooden intake remained unused for one year. A request then came from the Majhi community of Bahunipati village in Sindhu Palchowk district for this wooden intake so that they could similarly develop a water system to meet their drinking water needs. A local carpenter dismantled the intake to the extent possible, and after being transported to Bahunipati, reassembled it. The intake was then installed at the water source, Kalimati was used to make the tank floor water community received water immediately since the water source here was larger than the Heguwapati source.

This site was on a very steep slope that was washed away every year by landslide. The intake site including the underground tank also helped to stabilize erosion and landslide. The area is now well stabilized with a thick growth of vegetation (uttis).

Encouraged by this water supply, the Majhi community further decided to construct a permanent water collection tank at their village. At present, there are three taps in the village. The people use the extra water to grow kitchen garden for the first time.

This structure which I developed in 1982, although eliminated the need for cement, it was only by no means a structure which village technology of present day Nepal could handle. I needed something more simple, structurally which the villagers could make themselves at a cheaper price, so that one of their basic human needs could be handled by themselves.

During April 1988, I went to Ramechhap, Manthli Panchyat, to help small communities in solving their drinking water problems in an as simple way as possible. The apparent sophisticated, Kathmandu produced, wooden intake was replaced by a 1.5 to 2.0 inches thick, and about 9 inches wide and 4 feet long Khair wooden plank. A hold was drilled in the centre of the plank, about one and half feet below the top, with the help of a round chisel. A full thread 3/4 "nipple was fitted because I was using a 3/4" pipe. Washer for the socket was made from the HDP pipe piece. The washer was placed in position and heated. As soon as it started melting, I tightened the socket from both the sides with jam nuts.

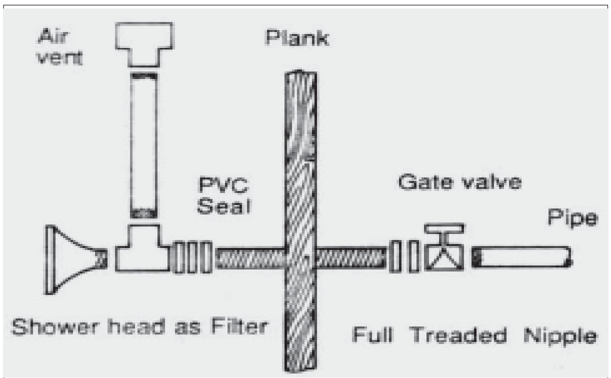

Figure 1

This tightening process automatically stopped the small fire and sealed leak between the socket and the wood. The next step was to install filter in the reservoir side. I used a 2.5 diameter HDP pipe filter with handmade holes. Plastic shower with enlarged holes can be also used which is still cheaper. A Tee was provided as the air vent (Sketch).

This intake can easily be fitted to any small spring and a small pool developed with a head of about 1.5 feet. Pipe can then be connected to carry water to the reservoir or tap stand as the case may be. The villagers can easily replicate and repair the structure. Its installations at the water source take another three to four hours of work or even less. I could provide drinking water to the community within three days in one of the system (Dumrey) where people were organised. In another system (Lisimpani) in the same Panchayat, it took more than 15 days because the people were not organised. Also the distance between the source and the water users was longer (1325 meter) in the second case than in the first (575 metre).

The second system also had a higher elevation difference which needed a break pressure tank. I used a 45 litre HD/PVC pressure breaker cum distribution tank whose cost at factory in Kathmandu was Rs 1000.00. This outfit greatly helped in saving construction time and ensured 100 per cent guarantee against leakage's, although the cost was on the higher side.

The pipes were connected by suitable couplings rather than by heat treatment methods, which is a skill that needs a long practice to reach to perfection. It is my general observation that not many of the rural drinking water projects use ferrul cock for water distribution. This result in uneven distribution of water, the lowest tap sucking most of the water. The resulting dissatisfaction among water users has let to complete disruption of the system in many cases. In both the project ferrul cocks were used and the beneficiaries taught how to adjust them for equal distribution of water. In both the places the beneficiaries were happy not only because they had piped drinking water, but also because they got the water within a short span, which was beyond their expectation.

TAPPING WATER
IN ANCIENT TIMES

Dr. Kiran K. Bhattarai

INTRODUCTION

This article is a translation from Nepali and deals with the ancient methods of tapping water as described in Varahamihira's 'Brihat Samhita', which was written in the year 533 AD (Sake 455). Various types of vegetation, their morphological and physiological feature, and termite mounds, have been described by Varahamihira as the indicators to tap ground water. Using the same indicators, the natural resources development project of Sri Venkatesware University in India claimed to have located well sites after surveying 450 ha of land. Varahamihira says 'Apo Nara'- water is life and compares streams of water in the ground to blood vein in the body - present all over. Varahamihira also mentions methods of cleaning thus tapped water. The manuscript deals with the following:

(i) Different signs and indicators of water (ii) Quality of water at different depth (iii) Stagewise indicators of water during excavations of wells (iv) Different methods of blasting rocks and (v) Methods of purifying water that has been found in water scarce areas.

Even in the early days, people realised that rainwater changes quality once in contact with the ground depending upon the type of soil it passes through. Varahamihira, suggests that before digging a well or pond, the soil quality must also be tested.

Varahamihira has divided water-carrying streams into veins according to the direction. Water veins coming vertically upwards from the ground, and originating from North, East, South and West are considered good whereas water originating in other directions are considered bad.

2.0 LOCATING STEPS

Varahamihira suggests the following steps in searching for water.

2.1 When surveying in any water shortage area, if a shrub of Bet (Calamus Tenius) in seen, measure 4'6 'west and dig 11'3' where water can be found. The water thus available is in from the western stream, Baruni. When digging in that area one finds following things (in sequential order).

(a) A pale coloured soil is seen after digging 4'4 (b) Yellow soil after further digging and (c) A stone that protects well water from contamination is found which has to removed to get tasty water.

2.2 When searching for water, if a rose-apple tree (Jamun) is encountered and if near to the east, a termite colony mound is present, measure 4'6 'to the south of the tree and dig 15' after which water will be found. When digging the following things are found (in sequential order).

(a) A fish at 3'9, b) A pigeon-coloured stone after further digging, c) Blue coloured soil and, d) Tasty, good quality water that will last for many years after further digging.

2.3 While searching for water in extreme water shortage areas, if a European Nettle Wood (Khari) tree is seen if a termite colony is observed to the west of the tree, measure 4'6 "to the west of the tree and dig 26'3" after which water be found. When digging the following indicators are encountered.

(a) A while gecko is seen a 3'9", b) After digging 7'6" from the ground, a black and white gecko is seen and a mixture of black and white soil is encountered after which black soil is encountered. Then plenty of long lasting water is available.

2.4 While searching for water in shortage areas, if a Bastrord Teak (Palas) and an Indian Plum (Bayer) shrub are growing together and whether a termite colony is present nearby or not, measure 4'4 "to the west of the shrub and dig 26'3 where water will be found. After digging 7'6" a poisonless snake named Tundum will be met after which tasty water will be found.

2.5 If a Bael Fruit tree (Bel) and Dumri are growing together measure 4'6 "to the south of the tree and dig 26'3" when water will be found. After digging 3'9 a black frog is encountered and if dug more, good quality, tasty and long lasting water will be found.

2.6 In desert if a (Bara) tree is present nearby and if to the west to the tree a termite colony is present, measure 1'6 "to the north of the tree, and dig 7'6" a special white creature is Biswamber is seen. After that a saffron coloured beautiful rock is met to the west of which water being strata is obtained, this strata dries up after three years.

2.7 While searching for water in dry areas, if a Smila Lanceaefoli (Chhatiwan) shrub and a termite colony is seen nearby measure "1'6 to the north of the tree, and dig 33'9" where creature is Biswamber is seen. After that a saffron coloured beautiful rock is met to the west of which water being strata is obtained. This water is tasty and healthy.

2.8 If a frog is seen beneath any tree or shrub in water scarce areas, measure 1'6" to the north of the tree or shrub and dig 33'9" where water will be surely found. While digging in such areas, a mongoose is seen after 7'6" then blue soil and lastly a rock is met. After removing the rock, plentiful water is found.

2.9 When tender and fresh grass and leaves are noticed in water scarce areas, water can be found after digging 9'. If herbs like Tribrita. (Indian Rhuberb), Andir (castor seeds), Geteurpadi (Chinde Briksha), (Turk's Turban Shrub), Seto Kantaki or flowering vines are noticed. Dig 3 "away from the herbs up to a depth of 22'6" when tasty water will be found.

2.10 If a two-headed centipede is seen while searching for water in water scarce areas, measure 3' to the west of the Centipede and dig 22'6 when water will be found. In other areas ground water does not flow straight but flows in Zig-zag directions. In water scarce areas ground water flows at very large depths. Therefore the following points should be thought of while searching for ground water in such areas.

2.11 If a Data Walnut tree is found in water scarce areas, and if to the north east of the tree a termite colony is present, measure 6'9 "to the west of the tree and dig 37'6" where water will be found flowing northwards. While digging, a frog will be seen first, after digging 7'6" greenish soil is seen followed by green soil, white soil and then a huge rock is seen after whose removal huge amounts of water is obtained.

2.12 If Walnut tree is found in water scarce areas, and if a termite colony is present to the east of the tree, measure 6'9 "to the south of the tree and dig 52'6" where a white and black coloured 1'6 long snake is found. From this place plenty of water bearing streams flow southwards. But this water is salty and hence not usable.

2.13 If an Indian Plum and Rhododendron tree are growing at the same place, and whether a termite colony is present nearby or not, measure 4'6 "to the west of the tree and dig 120' when water will be found. While digging is such areas, a scorpion is seen after digging 3'9". Then a white stone is found which when removed yields a southward flowing water stream. This water is very tasty. If digging is stopped here the water dries up after a shore time. Therefore, after further digging northward flowing water stream is met which lasts for a long time.

2.14 If a Sami Brissaka tree with plenty of whilte thorns is seen while searching for water, measure 1'6 "to the south of the tree and dig 282'6" at which depth water will be found. While digging in such areas, a black snake is seen after 3'9 "and after reaching 262'6" tasty long lasting water is found.

3.0 METHODS OF BREAKING/ BLASTING ROCK

After digging huge and unmovable stone is usually met at the end. This stone is the main hindrance in search of water after a lot of hard effort. It is therefore necessary to know the procedures for breaking the stone.

3.1 After all method of removing the stone have failed, make a fire on the rock using fire wood of the Bastrord teak and Tidu. After the stone becomes red hot, pour a mixture of milk and water on the rock when the rock crumbles into powder.

3.2 If the above method fails, make a fire on the rock using any firewood. Make a mixture of the seeds of Mothe, Kanjik, Surma, Gahat and Indian Plum (Bayer) and after keeping the mixture for seven days and nights, pour the mixture on the rock when the rock immediately breaks.

4.0 METHOD OF CLEANING THE WELL WATER

After water has been found and the well developed. If the water is not tasty but salty, bitter or harsh or in any way defective, the efforts put into the well becomes useless and people will not receive the service. Therefore, it is of prime importance to purify the water.

Varahamihira mentioned a mixture of Anjanbriskha

Mothe, Ushira, Rajkoshataki, Amala and Nirmal Briksha to be mixed with the well water. The well water then becomes pure and tasty. It can be thus inferred that people in ancient days did use medicinal herbs and plants to purify water and improve taste. Among the six herbs mentioned, Rajkoshataki (Luffa Cylindrica) stands out as the main biocidal ingredient. A sponge gourd or washrag sponge as it is known in English, Luffa Cylindrica is highly toxic to fish and frog. Its antiseptic nature has been also reported in recent times.

CONCLUSIONS

In a society where health care has not yet reached the majority, people still have faith, and resort to traditional forms of medicine. If more study and research is directed towards understanding the effects of herbs on water, a method of water treatment could be developed. This method would be socially acceptable and people might be more motivated to use them.

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A LESSON IN EVALUATING POTENTIAL COOPERATION JUMLA DISTRICT, NEPAL

Stan Justice

My first assignment after becoming a volunteer was the to survey an approved project in Khin Panchayat. PCV Kevin Bubriski and I found our way over two 11,000-foot lekhs to ultrajungly Khin. We were told in a strange Nepali Dialect, that the villages of Neta and Chaalaa were the most Suka Duka (hurting for water) place with Khin and Mhalay having less of a water need. The people of Neta were carrying water about 45 minute's round trip. There was no apparent technical problem so the survey was pretty straight forward. Considering the need for a water system, the villagers' show of enthusiasm (they wouldn't accept money for food and lodging) and the fact that the men had to carry water, we felt that cooperation would be good.

For Khin and Mhalay we found a small water source and surveyed down to the villages. At both villages have found small nearby water taps and people kept asking about 'khet pani' (irrigation water). They didn't seem very interests in drinking water. Our initial reaction was to recommend that a system not be built. But the taps were small, and looked like they might be contaminated. Also the Pradhan Pancha and a few other people seemed to support the project. We agreed to design and make a request for the water system.

Someone told us that the Chaalaa water source was way below the village, so we wrote if off as infeasible. It wasn't until we were about to leave that we learned about another water source above the village, which was almost one Kosh (2miles) away. We were expected back in Jumla shortly so we left without surveying the system. We should have asked more questions about Chaalaa from several different people.

After geeing supplies from Nepalgunj, I went to Khin, arranged for the porters and returned to Jumla. Neta sent men right away and they carried all the supplies for Neta system. Khin sent eight people one time and five people a few weeks later. Four of the Khin porters took their loads of pipe to Gotale Chola, where they had second houses; intending to build a water system there. After much waiting for rest of the Khin porters. I returned to Neta and build everything except the taps in two weeks. Even with a population of less than 200, over 200 people came to work regularly, neglecting their fields. They removed, cut and even burrowed under rocks to get the ditch a pukaa two feet deep. They wanted a durable water system.

In taking to the Prashan Pancha it was decided Khin and Mhalay were not going to the able to carry the rest of the supplies so we should build a system for Chaalaa using the pipe Khin had carried. Cooperation was not expected to be a problem since Chaalaa was worse off than Neta. I did the survey and retrurned to Jumla to see if enough pipe was available, then sent a letter asking Chaalaa, and departed with pipe. I grew tried of waiting for the porters so returned to Neta and built the taps.

They had the usual difficult time deciding where to build the taps and finally put both taps in a central location that few people really liked. I should have gotten more involved in the decision rather than decide.

Going to Chaalaa, I found that my letter had not arrived and five porters had taken the pipe to, Toshady another village in the Panchayat, which also wanted a water system. I rounded up nine porters and went to Khin village to try and get the pipe that was stored there. Everyone ran out of their houses yelling and screaming, refusing to let us take the pipe, even when Chaalaa offered to pay the Khin porters with food. So now there is pipe in four different locations (including some extra pipe) left over from the Neta Project and no one will give it up for the much-needed Chaalaa project. A policeman will probably have to go out and force the people to give the pipe to Chaalaa. What a mess - and to think it all could have been avoided by a better survey. I've learned two things from this:

1. The village must feel a need a for a water system before they will actively cooperate, and
2. Don't give anything to anyone (even on a loan basis and expect to get it back.

AN INTRODUCTION TO CAVITATION EROSION IN HYDRAULIC STRUCTURES

Dr. Jit N. Nayak

1.0 INTRODUCTION

Hydraulic structures like spillways are subjected to various types of effects. Spillways have to function under high pressure with velocities as high as 40-50 m/s or more. Irregularities in the form of hump, wave and other defects appear on the flow surface due to improper designs, and construction defects. These irregularities under very high velocity can cause cavitation leading to cavitation erosion.

2.0 CAVITATION

Cavitation is hydrodynamic process occurring in the regions of liquid flow where its pressure is reduced to the vapour pressure. The process is associated with formation of vapour and gas bubbles, and their pockets in the zone of minimum pressure disrupting the flow patterns. The phenomenon of cavitation is associated with sound, vibration, and energy loss. The gas bubbles while moving in the flowing liquid approach the high-pressure zone and suddenly collapses in the liquid. If the collapse occurs near the solid surface of flow, a very high-localised pressure is caused, resulting in pitting of the surface and fatigue. This consequently leads to cavitation erosion.

Cavitation, as hydraulic phenomenon, was observed by Italian scientist Bartello, in 1779. Reynolds, Boil, Taylor, Numaki, Frankel and other scientists studied the effects of cavitation on hydraulic structures built in the first half of the 20th century. Many hydraulic structures in the world are subjected to this phenomenon which has affected their performance. The spillway tunnel of the Boulder Dam (USA) has been affected by cavitation erosion. A convex upward hump in the spillway surface resulting from construction defects caused deep erosion in the spillway. The eroded cavity was 35m long, 9.5m wide and 13.7m deep. The surfaces of spillways of the Grand Coolie Dam (USA) and the Bratskya Dam (USSR) have been also subjected to cavitation erosion.

3.0 SOURCE OF CAVITATION

Cavitation sources can be divided into two groups as those, which depend upon the flow contours of structure at design stage and those caused by the construction irregularities of the structural elements.

The first source consists of members of the spillway structure whose geometrical characteristics are fixed during its design phase. Energy dissipaters, bell mouths, divide wall of gate wells etc are some of such elements. The second source consists of local irregularities like reinforcement end protruding in the flow, hump, smooth concrete members coming up due to the defects in concrete casting methods, joints of members at unequal levels, and welded joints of metal lining.

4.0 CAVITATION TYPE AND ITS STAGES

Considering the character of cavitation in continuous flow regime, cavitation in hydraulic structures can be broadly classified into smooth stream lined and non-smooth stream lined cavitations. Smooth stream lined cavitation can be further classified into three categories.

Type I, is a bubble cavitation in which the vapour gas bubbles separate the edge of flow elements having maximum vacuum pressure. Type II appears in the form of their cavitation torch on smooth walls, which separate the boundary layer in the location of minimum pressure. Type III may occur in the form of cavitation torch filled with vapour gas bubbles. The first type of cavitation, is observed on very smooth stream lined members whereas the second and the third types can be seen on medium smooth stream lined elements. These types of cavitation originate in the flow through crest of spillways, smooth BellSouth of pressure spillways and other such components.

The character of cavitation field in the continuous flow regime at non-smooth stream-lined members cause IV-type of cavitation, in which the flow is associated with formation of separation zone and is known as vertex cavitation. This type of cavitation can appear in energy dissipaters, irregularities of spillway surface and gate grooves. Some of the well-known irregularities, which occur on the surface of spillway structures, are shown in Figure1.

1- cavitation tourch; 2- source of cavitation of origin;
3- cavitation erosion; 4- concrete material

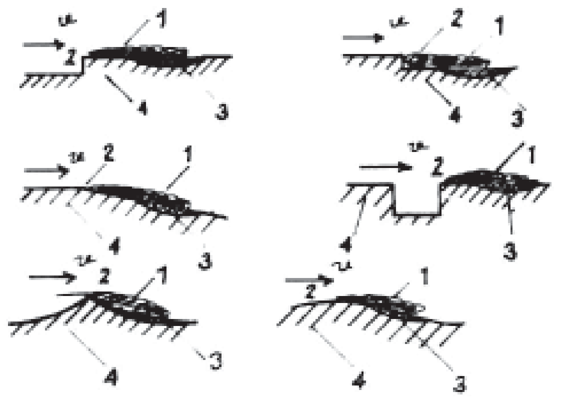

Figure 1. Flow-Separation for Different Irregularities

The condition for origin of cavitation can be expressed as.

$$h = Ha - hv < Hc \quad (1)$$
$$\text{or } k < Kc$$

Where, h = absolute pressure at a given point in the flow; ha = atmospheric pressure depending upon the height of a point from the mean sea level; hv = vacuum pressure; Hc = critical pressure corresponding to beginning of cavitation; k = cavitation parameter or number which characterises the hydrodynamic condition of flow; and Kc = critical cavitation parameter for beginning of cavitation.

Equation (1) suggests that cavitation occurs whenever the absolute pressure in the flow is less than the pressure of vapour formation. However, in the flow of real liquid cavitation begins when the absolute pressure in the flow is little more than the pressure of vapour formation.

Generally, the hydrodynamic condition of flow pattern is criterion for characterising the cavitation parameter, which can be expressed as

$$K = \frac{Hch - Hc}{V^2 ch/2g} \quad (2)$$

$$\text{and } Hch = hs + Ha \quad (3)$$

Where, Hch= characteristic absolute pressure at a point near flow element without considering the disturbance in the flow caused by this element. hs = surplus pressure over the flow element, Vch = characteristic flow velocity near the flow elements, g = acceleration due to gravity.

Cavitation is distinguished in three main developed stage which is the ratio of cavitation parameter corresponding to certain working condition K, to the critical cavitation parameter Kc. This can be expressed as

$$ß = K/Kc \quad (4)$$

The three main developed stages of cavitation are as follows

(i) Initial stage (0.7< ß < 1.0) - This stage is characterised low intensity of cavitation erosion and insignificant hydrodynamic effect on the flow element (Figure 2)

(ii) Developed stage (0.3<ß<0.7) - Significant hydrodynamic effects on the flow member exists in this stage, and high intensity of cavitation erosion occurs.

(iii) Stage of super cavitation (0.0 <ß ,0.3) - This stage is characterised by low hydrodynamical effects on the flow members and insignificant cavitation erosion.

1- cavitationless flow regime; 2- initial stage;
3- developed stage; and
4- stage of supercavitation

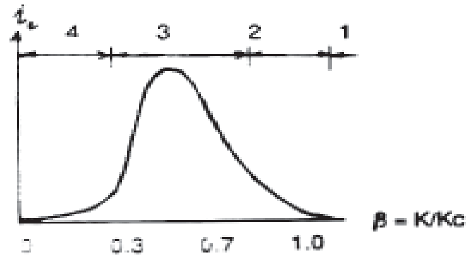

Figure 2 Cavitation Stages

CONCLUSION

The prediction of cavitation erosion of flow elements of hydraulic structure is essential during the design stage, so that the effects is minimised, Cavitation erosion on surface of existing hydraulic structures should also predicated to ensure their satisfactory performance during operations.

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BOOK INTRODUCTION

IRRIGATION DEVELOPMENT IN NEPAL

Author: Som Nath Poudel
Publisher: Mrs Kamala Poudel, 1986, Ksthmandu.
Pages: 291
Chapters: Introduction, Irrigation Development in Nepal, Irrigation Development Perspective.
References: 52
Price: Not Mentioned

Irrigation development in Nepal by Som Nath Poudel outlines details of irrigation development in the government sector during the pre and the last six planned development periods. An overview of the non-governmental irrigation systems, those built by the farmers in the terai and the hills, is also made, the book contains informations on area brought under irrigation in efach plan period, technical aspects of each scheme, construction duration and the investment cost. Difficulties faced in development of irrigation are also highlighted. In most cases, excessive sedimentation of headworks have rendered irrigation system non-functional.

The section on irrigation development perspective recognises the options of utilizing both the surface and groundwater resources for irrigation development. Diversion and storage schemes have been identified by the author as the systems for irrigating additional land in the terai. The author mentions that groundwater utilization should receive less priority because of the inherent difficulties in obtaining energy source, and maintaining pumps. Development of irrigation systems in the hills is justified from the point of view of ensuring regional parity, alleviating llocalised food deficit, and addressing the deteriorating environmental conditions, even though most areas in the hills having easier access to water sources and better land have already been provided with irrigation facilities by the farmers. Development of newer systems are severly constrained by high cost and low economic returns, it is pointed.

The volumnous book is presented with numerous hard data and information of almost all past irrigation systems as well as the proposed ones. The book canserve as a very useful material for inventory and post-mortem of the systems built in Nepal. At places however, the presented materials appear little redundant as their relevancy in the text is missing. A conclusion from the author would have greatly improved usefulness of the book. The author deserves credit for his efforts in presenting the experience of irrigation development in Nepal

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