INTEGRATING INDIGENOUS AND MODERN KNOWLEDGE OF WATER MANAGEMENT FOR INCREASING CROP PRODUCTIVITY IN HIMACHAL PRADESH, INDIA

INTEGRATION DES CONNAISSANCES INDIGENE ET MODERNE DE LA GESTION D'EAU POUR AUGMENTER LA PRODUCTIVITE AGRICOLE EN ETAT D'HIMACHAL PRADESH, INDE

A. K. Randev[1] and Randev Uma[2]

ABSTRACT

This research paper studies the existing irrigation systems and their management and analyze various problems faced by the farmers and to identify the issues of water management in traditional and modern methods for optimal use and conservation of water on sustainable basis. An economic analysis reveals about 81.5% of the total cultivated area as rain fed. The productivities of important crops under rain fed conditions have been worked out to be about half to one-third of those under irrigated conditions. Though the net irrigated area has increased by about 3% under minor irrigation schemes during the last decade yet the total production has not grown significantly. About 62% of kuhls (water channels found in precipitous mountain areas) have been reported to be managed privately in a traditional way. At the present level of water management, the weighted irrigational development index has been worked out as about 46%. The study has emphasized upon various issues of 'composite method' of traditional and modern approach for conservation and utilization of water which may increase the irrigational development index. The study shows that the centuries old water harvesting structures of various sizes have been serving the water users successfully even today, mainly due to a comprehensive integrated planning taking into consideration all the relevant parameters.

1 Professor (Agril. Econ.), Dr YSPUH&F, RHRS, Mashobra, Shimla-7, H.P.-India, V.F. Div WRE, AIT (Sept , 1992), Bangkok, Thailand. ICID Secretary WG on On Farm Irrigation systems. 0091-177-2640434, mob 094184-58558, Fax 0091-177-2740261, e mail randev26@rediffmail.com
2 Principal, LBS Govt College, Saraswatinagar, Jubbal tehsil, Shimla, H.P. – India

Key words: *Indigenous water management, Crop productivity, Integrated planning, Climate change and water availability, Himachal Pradesh (India).*

RESUME ET CONCLUSIONS

L'eau - la contribution la plus essentielle a un impact énorme sur les cultures de la productivité pour sa disponibilité pour les cultures a été observé affectant la productivité de zéro à cent pour cent dans des situations de terrain. «Productivité» étant un terme relatif donc parmi les «eaux» de toutes les entrées besoins accent au maximum car il permet dans un premier temps, toutes les ressources utilisables dans le bio-monde et d'autre part de sa «rareté relative a été signalé à augmenter avec l'augmentation du nombre de ses ' usages et usagers. La disponibilité par habitant de l'eau en Inde a diminué d'environ 65 pour cent au cours de la dernière environ cinq décennies, ergo, un besoin urgent s'est fait sentir d'intégrer les traditionnels ainsi que les méthodes modernes de gestion de l'eau de manière à accroître la disponibilité par habitant et d'améliorer l'eau la productivité dans un rapide chemin. Ce document a été élaboré concernant l'approche stratégique avec les objectifs (i) d'étudier le niveau actuel des systèmes d'irrigation et de leur gestion et (ii) d'analyser les différents problèmes rencontrés par les agriculteurs et d'identifier les différents aspects de la gestion de l'eau conduit à une utilisation optimale et la conservation de l'eau sur une base durable. Une analyse économique grâce à des techniques économétriques et la notation révèle environ 81,5 pour cent de la superficie totale cultivée en pluviale avec l'intensité culturale 173,6 pour cent. Les productivités des cultures importantes dans les conditions pluviales ont été élaborés à environ 2 à 3 fois moins que les conditions irriguées. Quoique surface nette irriguée a montré une augmentation d'environ 3 pour cent par diverses méthodes d'irrigation comme les canaux, réservoirs, kuhl, puits et forages, ainsi que le transport d'irrigation au cours de la dernière décennie, mais les niveaux de production total n'ont pas montré une croissance significative. Plus encore, en dépit de la chute de la pluie une bonne moyenne de 1210 mm par an au cours des 2 dernières décennies productivité des principales cultures n'ont pas montré une augmentation significative en raison du fait que la chute de pluie a été jugée insuffisante (de -20 à -59 pour cent de la normale) à la fois de l'exigence de l'eau au cours de différents stades de croissance des cultures. Les résultats ont également révélé des problèmes d'irrigation que le problème de production dominant face d'environ 99 pour cent des producteurs de fruits. La relative rareté de l'eau peuvent être minimisés par une planification des projets des ressources en eau strictement multi spécialistes des disciplines grâce à l'intégration des méthodes indigènes et modernes de gestion de l'eau en mettant l'accent sur la consommation d'eau à des fins domestiques et d'irrigation pour parmi les différentes méthodes d'environ 81 pour cent des périmètres irrigués zone a été trouvé à être irriguée par kuhl et notamment d'environ 62 pour cent des kuhl ont été signalés à la gestion privée d'une manière traditionnelle sur une base durable. Au niveau actuel de gestion de l'eau, l'indice de développement pondéré d'irrigation a été élaboré à environ 46 pour cent. L'étude a abouti à une conclusion catégorique des diverses questions de «méthode composite» de l'approche traditionnelle et moderne pour la conservation et l'utilisation de l'eau parmi ses «différentes utilisations prévues des différents paramètres des différentes questions en augmentant simultanément valeur de l'indice (> 46%) de la gestion de l'eau comme psychologiques, éducatives, sociales, économiques, institutionnelles, techniques et environnementales sont prises en charge au stade de la planification et la mise en œuvre. Les interactions entre les paramètres question diverses ont montré la dominance d'une part des siècles économique et technique des questions et d'autre part les structures *de récupération d'eau vieux de différentes tailles ont été au service des usagers de l'eau avec succès, aujourd'hui encore, en raison du fait que la planification intégrée qui a été fait avec beaucoup d'intelligence dans ces projets impliquant près de tous les paramètres de l'environnement le plus important comme la plantation d'essences forestières au climat favorable autour de récupération de l'eau au design traditionnel des structures construites avec des matières premières disponibles sur place qui ont conduit au maintien du cycle hydrologique trop entre autres qu'il est d'autres usages.*

Mots clés: *Gestion d'eau indigène, productivité agricole, planification intégrée, changement climatique et disponibilité de l'eau, Himachal Pradesh (Inde).*

(Traduction française telle que fournie par les auteurs)

1. INTRODUCTION

Degradation of natural resources must be minimized for better living of the present and the future generations. Judicious use of resources requires a holistic planning at every stage of research and development. Development has caused environmental degradation in the previous years in spite of economic planning due to lack of integrated approach. Water gets affected to the maximum in terms of quantity and quality. Agriculture is the largest water consuming sector in India. By 2050 India will be the most populous country in the world, hence a dire need is felt at the national level to increase productivity in agriculture with limited cultivable land (46% of the total area: Datt & Sundharm, 1997), and water has to play a vital role in this.

Among all the inputs that are responsible for increasing crop productivity, 'water' needs maximum emphasis because: (a) it makes all the other resources utilizable and (b) it is a scarce commodity. The scarcity will be more severe as the time passes. The per capita availability of water in India has decreased by 65% during the last five decades in spite of huge investments on water resource development. Himachal Pradesh located between $30^0 22'$ and $33^0 12'$N latitude and $75^0 47'$ and $79^0 4'$ East latitude over an altitude range 350-7000 meters amsl receives 180 to 3000 mm rain fall annually. Yet only about 20% of the total cropped area is irrigated. Knowing that water supply is inelastic but its demand is elastic, the role of management of water resource, so as to match demand and supply becomes imperative. Hence a dire need is felt for planning irrigation with simultaneous development of related infrastructure in rural as well as urban areas through integration of traditional and modern methods of water management. Towards addressing the water management issues, this paper was developed with two objectives.

2. OBJECTIVES

(i) To study the existing level of irrigation systems and their management and analyze various problems faced by the orchard growers and,

(ii) To identify various issues of traditional and modern methods of water management leading to optimal conservation and use of water on a sustainable basis.

3. MATERIALS AND METHODS

One hundred samples were drawn from Shimla district by adopting purposive and multi-stage stratified random sampling. Primary data were collected on controllable factors like number of plants, farm yard manure and fertilizers and insecticides and pesticides used by the fruit growers and general problems in addition to production and marketing faced by the orchardists along with their responses for solving environmental problems for the period 2006-08. The time series data on production of 6 cultivars of apple (a representative crop in the area) namely Royal Delicious, Top Red, Vance Delicious, Skyline supreme, Hardeman and Red Spur covering about 58 per cent of the total population of different varietal set- up of high density plantations at the research station were collected. Also collected were the data on uncontrollable factors like temperature, rain fall, hails, snow fall, humidity and evaporation for 2 decades i.e.1988-2008 (Anonymous, 2008). Data were analyzed by calculating weighted averages, multiple responses and by using Cobb Douglas and Quadratic form of production functions of the form:

(i) $Y = b_o X_i^{bi}$ (ii) $Y = bo + bi\, Xi +/- X^2$ where, Y = Total physical production of 6 cultivars of apple and X_{is} are independent uncontrollable variables where i runs from 1 to 8 as X_1 maximum temperature, X_2 minimum temperature, X_3 Rainfall, X_4 Snowfall, X_5 Hails, X_6 Humidity (morning), X_7 Humidity (evening) and X_8 Evaporation.

Flow diagram based on logical method of analysis has been used to inter link weather parameters to water availability viz. Temperature (Land and Water) → Rainfall/Snowfall/hails → Evaporation → Humidity; and conservation and utilization of water. In each development activity water leads to simultaneous efforts, in- built in the plan, for conservation aspect so as to create a balance between harvesting and regeneration, for these efforts affect hydrological cycle significantly through creation of water harvesting structures and growing vegetation in a balanced manner.

Data collected from primary and secondary sources were analyzed for objectives (1) and (2) by calculating weighted averages, multiple responses and by using law of equi- marginal utility i.e. MUw1/p1= MUw2/p2 = MUw3/p3 … MUwn/pn. Objective (2) has also been analyzed by adopting simultaneously the natural system assessment with economic valuation methods through scores to develop irrigation development index by the following formula : IDI = Total output index / Total input index ; and arriving at equality of demand for and supply of water utilization i.e.

$$\sum_{i=1}^{n} \text{Demand} = \sum_{i=1}^{n} \text{Supply}\ ;\ \text{i runs from 1 to n uses} \qquad \ldots (1)$$

On various issues of synergistic planning involving traditional and modern practices of water management, indices were developed upon taking into consideration the problems faced by the orchard growers, government interventions and scientific recommendations.

4. RESULTS AND DISCUSSION

4.1 Existing Status of Irrigation (Development scenario)

Traditional Methods. A composite method comprising the use of religious and scientific approach has been reported in "*Aaj Bhi Kharen Hain Talab*" (Ponds exist even today) by Mishra (1998). All the steps involved right from planning till completion of the ponds have been explained so meticulously that enforces an individual to review the modern methods of ponds construction in the light of traditional methods. The traditional ways pertaining to (i) selection of sites (ii) technical persons for undertaking various jobs at various stages of construction of ponds. (iii) all environmental factors related with overall performance of the ponds ; have given an in-depth view of the operational success of these ponds. Briefly, the compilation has revealed that all inhabited areas used to start establishment efforts with the initiation of water resource structures in harmony with natural events in almost all parts of the country. In Delhi about 350 small and big ponds existed during 1800-1900, in 1885 in the 14 districts of erstwhile Madras (now, Tamil Nadu) about 43,000 ponds were used, in Karnataka about 39,000 ponds have been reported. Similar situation existed all over India in the past. In all about 11 to 12 lakhs of ponds used to be operational up to the beginning of 19th century which used to cater the need of water under multiple uses from the current monsoon to the next pre-monsoon period. Traditional methods of water resource structures have been a great success in various parts of Rajasthan. Exemplary site could be found in Jaisalmer district of Rajasthan which receives minimum annual rain fall of 164 mm. A number of ponds constructed centuries ago with the then available resources and technologies have been still operational and are eye openers for the modern water engineers. Similarly in the Himalayan region hundreds of ponds have been serving since their construction. Diversified designs have been a matter of pride for all the Indians because idealistic approach followed in those days used to be 'no ponds no water, no water means no village,' which holds true even at present if life is to be sustained.

Modern Methods. The land being inelastic, growth in crop productivity is possible through irrigation. Water resource potential of different river basins of India is reported to be 1869.4 BCM and utilizable water only 1149 BCM comprising surface water of 690 BCM, groundwater of 369 BCM and irrigation return flow of 90 BCM (Anonymous 2010).

Indus and Ganga river systems contribute about 32% of the total water resource potential of India. The main tributaries of Indus and Ganga namely, Chenab, Ravi, Beas, Sutlej, Yamuna and Tons flow through Himachal Pradesh. The plan outlays amongst various heads of development have shown an increase of about 119 % specifically for irrigation and flood control over 1998-99 (Table-1). Increasing trend has been observed in other related heads undertaking water related programs except in agriculture and allied services during the decadal period.

Table-1. Plan outlays in the state of Himachal Pradesh (Plan des dépenses dans l'état de Himachal Pradesh)

Sr. No.	Heads of development	1998-99	2009-10	Decadal variation Increase(I)/ Decrease(D)
1	Agriculture & allied services	12.70	11.08	D
2	Rural development	4.82	5.30	I
3	Special area development program	0.28	0.61	I
4	**Irrigation and flood control**	**4.58**	**10.03**	**I (119%)**
5	Energy	15.71	13.14	D
6	Industry & minerals	1.89	0.79	D
7	Transport & communication	13.62	20.28	I
8	Science, Technology & Environment	0.10	0.59	I
9	General Economic services	3.73	3.54	D
10	Social services	40.63	32.30	D
11	General services (Jail etc.)	1.94	2.34	I
12	Total (In Crore Rs.)	1444	2700 ($570m)	I
	Percentage	100	100	

Various state departments have been involved for developing irrigation potential in the state **Table-2**. The department of irrigation and public health has been engaged in undertaking major and medium irrigation projects whereas other departments have been contributing to irrigation potential through minor irrigation schemes. Consequent upon the plan outlays, the ultimate water resource potential in Himachal Pradesh has been reported to be 0.353 million hectares (Mha) and potential created up to tenth Five Year Plan was 0.263 Mha (75 % of the total potential) including 0.050 Mha (14%) culturable command area (CCA) under major and medium irrigation projects and 0.303 Mha (86%) under minor irrigation projects.

Table-2 Various development departments of the state and programs of water resource development (Divers services de développement de l'État et des programmes de développement des ressources en eau)

Sr. No.	Name of the department	Specific schemes or programs
1.	Department of Irrigation and Public Health	Major and minor irrigation projects.
2.	Department of Agriculture	Watershed development programs/ watershed management schemes
3.	Department of Horticulture	Water conservation and utilization schemes through water harvesting structures etc.
4.	Department of Forests & Environment	Through watershed/eco tourism schemes
5.	Department of Rural Development	Watershed development projects.

Over all irrigation potential utilized in the state is 82% of the total potential created which is greater than the national average of 74%. But ground water development has been 30% less than the national average of 58% (Table-3).

Table-3 Ultimate irrigation potential and potential created and utilized in H.P. vis-à-vis India (Potentiel d'irrigation Ultimate et le potentiel créés et utilisés dans HP vis-à-vis de l'Inde)
('000 Ha)

Sr No	Particulars	Himachal Pradesh	India
1	Ultimate Irrigation potential		
	Major/medium irrigation	50	58465
	Minor irrigation	303	81428
	1.3 Total	3.53	139893
2	Irrigation potential created up to Xth Plan		
	1.1 Major/medium irrigation	15.5	42277.1
		(8.9)*	(34381.7)*
	1.2 minor irrigation	247.7	80985.5
		(205.8)*	(56704.4)*
	1.3 Total	263.1	123262.5
		(214.7)*	(91086)*
		81.60**	73.90**
3	Ground water development		
	Net available	0.39	399.25
	Stage of ground water development (%)	30	58

*Irrigation potential utilized ** percentage

In Himachal Pradesh about 12% of total geographical area is the net sown area of which, 29% is irrigated. The net irrigated area through minor irrigation schemes like canals, tanks, wells/tube wells and other sources has increased by about 6% between 1998 and 2007 and their number has increased by 29, 172, 38 and 0.40 per cent, respectively. The maximum area is irrigated by *kuhls* (80.90%), followed by wells and tube wells (14.63%), canals (3.81%) and tanks (0.65%). About 62% of the *kuhls* are managed privately in a traditional way on sustainable basis. As a result of an increase in irrigated area due to developmental efforts, area under apple and vegetables has increased from 85631 to 94438 ha (about 10%) and 33240 to 58743 ha (77%) during 1998-99 to 2008-09, respectively. At the same time increased irrigation potential utilized has added to crop productivity benefiting the farmers. Mostly all the concerned departments have worked in isolation and contributing to the total irrigational potential. Since Independence water related programs have mainly concentrated on large dams, reservoirs and canal systems, but have ignored minor works which have played a significant role in growth of irrigation potential.

4.2 Existing Status of Irrigation (Research Senario)

Relative scarcity of Water. Demand for water among various uses is expected to increase by about 3 – 4 times in the next 20 years. Thus a further increase in the gap between demand and supply unfolds disastrous negative environmental impacts. Total requirement of water is likely to increase by 34% (813 to 1093 BCM) by 2025 in India (Anonymous2009).

Gaps in water availability. A Socio-economic study has revealed 76 per cent gap between demand for and supply of water with respect to top priorities of domestic and irrigation on unit area and unit household basis.

Water Resource use impact on crop productivity. Adequate quantities and required number of timely irrigation has been found to increase productivity in general by 2.3 times thereby leading to an inference of almost doubling the production from the existing resource base, simultaneously providing employment to the population (Randev, 2005).

Cost effectiveness of micro irrigation systems. An economic study on drip irrigation system in orchards of Himachal Pradesh (Randev, 2006) has revealed cost effectiveness of the system with respect to economy in labor use and other inputs' use efficiency including irrigation (66%) followed by efficiency in water and fertilizer use (25% in each) and enhanced levels of yield (35%). Economic parameters show higher undiscounted benefit cost ratio (16%) under drip irrigation system than the rain fed situation. Higher productivity levels under flood irrigation and 30-79 per cent water saving in fruits, vegetables and flower crops under drip irrigation system have been indicating higher irrigational efficiency.

Impact of climate change on water availability. An economic study on impact of climate change on apple productivity in Himachal Pradesh has revealed that amongst all the weather parameters, temperature is the pivotal factor, controlling the occurrence of other parameters through controlling hydrological cycle in micro as well as macro scale. Overall difference in the range of annual maximum temperature was about 24.41% during the previous two decades (1987-2007) indicating 'warming up of the eco-system'. It will deny the chilling need at certain growth stages of apple. Also, month-wise data have revealed that poor rain during first three months in the dormant stage has brought drastic fluctuations yielding as low as 1 kg/tree during 1999, 1.707 kg/tree in 1993-94 and 1.766 kg/tree in 1989-90. Whereas 20 – 50 % of the required rain during the dormant stage during the same period has brought significantly higher yields – as high as 53.3 kg/tree in 2007-08 (Randev 2008). More interesting inference of average annual rainfall during the two decades to the tune of 121 cm – an average best for normal production – has been met but at irregular intervals and not at required intervals of growth stages, thereby bringing production differential.

In the light of above research studies it can be inferred that crop productivity can be sustained only if crops get water at required intervals of time of different stages of growth. If water availability is irregular, productivity variation will occur.

Problems of orchard growers. Irrigation problem has been reported by about 99% of the respondents in the study area inter-alia other production and marketing related problems (Randev, 2008).

4.3 Irrigation Development Index (IDI) at the Existing Level

In the light of development scenario over traditional and modern era, IDI at the existing level of resource use has been worked out as 0.46, which shows impact of irrigation on total output to the tune of 46 per cent and the remaining 54 per cent needed to be covered under different issues as per the values at the existing status. Individual behavior has sharpened through 'education' followed by social, economic and technical interactions. Institutional vision is to be focused on environmental parameters specifying multi objectives simultaneously within the budget provisions in a phased manner.

Table-4. Weighted Irrigation development index (WIDI) and irrigation development index (IDI) at the existing level (L'indice pondéré développement de l'irrigation (WIDI) et l'indice de développement de l'irrigation (IDI) à leur niveau actuel)

Sr. No.	Particulars/Issues	Weighted IDI	IDI at existing level
1.	Psychological	12	6
2.	Educational	12	7
3.	Social	12	6
4.	Economic	12	3
5	Institutional	20	10
6	Technical	20	10
7	Environmental TIDI	12 1.00	4 0.46

Due to the development and research efforts/programs, net irrigated area has increased by about 3%. However, the total production levels have not shown a significant growth despite a good average annual rain fall of 1210 mm during the last 2 decades. This is mainly because, though the rainfall quantity as a whole was adequate but its time distribution was erratic, most of the time missing the crucial stages of the plant growth when irrigation becomes essential. The problem due to the erratic nature of rainfall can be addressed by planning water resource projects strictly by multi disciplinary experts through integration of indigenous and modern methods of water management with emphasis on consumption of water for domestic and irrigation purposes.

4.4. What Ought To Be / Optimum Status for a Balanced Water Growth

In order to achieve a balanced growth in relation to water resource, various issues on synergizing irrigation through a composite method involving traditional and modern methods of water management has been considered essential which are grouped here under.

Various Issues on water resource development projects

Psychological. As the psychological factors like attitude of an individual form the basis of success/failure of the project, hence attitude of 'owning by oneself' has been advocated in initiating any development project All the individuals associated with the project at any level need to develop this attitude.

Educational. Literate mind grasps, responds and performs better in relation to any sub activityunder a project, thereby increasing overall efficiency of the project output.

Social. Project influences each individual in the society therefore social welfare during growth of the society has been found to be a 'must' therefore socio-economic parameters need to be addressed on priority at every stage of the project.

Economic. Management of resource structure in order to achieve objectives of the project economic indicators need to be specified in the project related with both traditional and modern techniques and the resource base available, so economic issue (e.g. specification of variables etc.) forms an important aspect of the project. Financial aspect may be dealt within the economic issue leading to financial viability of the project.

Institutional. Agencies involved in conceptualizing projects for development, may be under public or private control, are the pioneers in developing a specific activity.

Technical. Technical issue comprises a complete set of technical knowledge on traditional and modern methods of water management to be used to transform man- made and natural assets into final goods and services.

Environmental. The specification of environmental parameters depends upon the depth of vision of the project formulators as the parameters can be extended up to tertiary levels. The parameters should, therefore, be specified right from the selection of the site, naming the site, right time of each event based on religious considerations and any other event of water resource development project and all variables related with vegetation-water relationship up to tertiary level.

4.5 Interactions among Various Issues

Interactions among psycho-socio-techno-economic parameters reveal that individual's attitude (beneficiary in the command area of water resource project) towards developmental efforts in water related projects specifically should be positive, imaginative and creative. It should be strengthened by timely publicity of the project through communication media and awareness camps so as to have full participation of the beneficiaries and to make them fully aware about the finiteness of water, it's conservation and judicious utilization as opined by about 99 % of the respondents (Randev 2007).

Though a large number of projects/programs of water resources development have been implemented with huge investments, yet continuous and visible growth has not been possible due to individualistic approach of the departments and their working in an isolated manner. It has been inferred from different research studies that when an economic activity say 'Water' related project is to be developed by different departments for a particular site, synergistic approach by 'composite method' must be adopted. Specifically, the updated National Water Policy (2002) has given emphasis on integrated water resource development projects and management for optimal and sustainable use of available surface and ground water and prioritized the water allocation to different sectors.

In the light of above discussions synergistic approach based on the composite method has to be followed by multi disciplinary experts at every stage of the project say through formulating integrated water resources development projects simultaneously taking into consideration infrastructural development like construction of irrigation channels, drainage lines, water harvesting structures and vegetative measures based on 'complete development' of the project area. Different development departments must specify joint action with respect to area, time of works to be undertaken so as to minimize the costs and upgrade the quality of the work.

4.6 Steps for Enhancing Irrigational Efficiency

In the light of various issues under synergistic planning of the composite method, the various steps involved for enhancing irrigational development index, the following strategic steps need to be followed.

Setting Trade-offs to ensure participation. Intra- agency and inter-agencies participation is needed for making project a success. Trade-offs among various agents have shown that at the lower costs higher level of social benefits with minimum loss to the environment can be obtained. Better modus operandi has been to establish an 'independent unit' having multi-disciplinary experts solely responsible for all the works of the project right from the formulation to completion stage so full time workers needed to be employed and not as additional duties to the existing workers.

Setting pivot and specifying the multi objectives. Irrigation has been one of the uses of water and under synergistic planning pivot should be Water Resource project and not only the irrigation project. Thus water resource use can be prioritized as shown in a cyclical way Flow chart – 1.

Domestic

Hydro power | **Irrigation**

\ /

Environmental < -------- WATER RESOURCE ----------→ Navigation

Fig.-1 cyclical role of water (Rôle contracyclique DE L'EAU)

Specify demand for and supply of water simultaneously - sub activity wise. Demand for each sub-activity based on number of users is to be finalized and for all the sub-activities summation of individual demand will be providing the total demand for water in that area. Accordingly supply of water is to be ascertained from the main source, if not sufficient additional storages to tap water within the project area are to be delineated.

All other related infrastructure is to be planned depending upon the demand and supply situation. Viz. Road development (for construction and maintenance by supplying all the inputs), plantation program to create green water as it assists in balancing hydrological cycle, laying down pipes for domestic. Irrigation and drainage (to avoid water logging etc).

Most importantly, depending upon the budgetary constraint, multi objectives can be met in phases provided provisions are planned in advance for complete and scientific development of an area. WATER RELATED PROJECTS NEED JOINT ACTION BASED ON TRADITIONAL AND MODERN METHODS OF WATER MANAGEMENT.

Special requirements.

- In integrated water resource development (IWRD) projects adopting the composite method, role of vegetation has been found to be of utmost importance - like role of a forester. Hence, in the vicinity of water harvesting structures suitable forest species or the fruit trees should be planted.
- Imbalances in hydrological cycle have been observed to be reverted if 'foresters' can work out number of plants per 100 or 1000 say – living organisms (i.e. Animal/plant ratio) responsible for CO_2 emissions which are further responsible for rise in temperature. Thus temperature in the command areas can be kept under controllable limits.
- Secondly, for infrastructural developments falling of plants/trees may be allowed without delaying the projects provided foresters are able to change the new planting pattern as per the design of the project – even new plantations more in number to maintain the gaseous balance. This will bring a change in the land use only and will not lower the forest plantation with the passage of time. Thus land use can be maintained and sustained.
- Thirdly, forest plantations may not be confined to forest areas only, instead rural as well as urban areas need to be covered under forest plantations (forest species to be specified technically by the foresters which should be need based in the locality and climatically suitable). Man plant ratio can be worked out.
- Fourthly, provisions for infrastructure development especially roads - may be temporary in forest area will have dual benefits - can be put for assisting villagers within the jurisdiction or in the vicinity of forests and enable forest department also(if say roads planned in a geometrical way) to control forest fires.
- Specific role and the most important role of foresters can be specified in at least water resource, road or buildings construction (govt or residential) projects. So as to maintain a balance of water + environmental parameters between urban and adjoining country side.

The study has strengthened the inference of the superiority of the 'composite method' comprising traditional and modern approaches for conservation and utilization of water amongst its different uses for enhancing irrigation development index value. The composite method will improve quality of water as well as the atmosphere and quantity of water amongst other benefits in the long run.

5. CONCLUSIONS

1. The relative scarcity of water steers to plan water in a scientific way by adopting multi objective planning based on traditional and modern methods of water management.
2. Water due to its multiple uses by one and all the living and non living resources requires sensitive and serious efforts from one and all departments by keeping budgetary provisions and undertaking jobs related to water conservation and its judicious utilization considering traditional and modern technologies.
3. A balanced growth of rural and urban areas needed for healthy environment at micro and macro levels through integrated water resource development projects in which the role of 'the foresters' is of 'utmost' importance.

4. The composite method can sustain hydrological cycle inter- alia other benefits of economies of scale.
5. Such type of projects need to be independent with full time workers required during the gestation/transformation period.

REFERENCES

Anonymous (2001). Report on Minor Irrigation Census – H.P Directorateof Land Records, Minor Irrigation Cell, Kusumpati, Shimla H.P. :127.

Anonymous (2005). Annual Season And Crop Report For 2004-2005. H.P. Govt. Directorate of Land Records, Kusumpati, Shimal H.P. :Xvii- XIX.

Anonymous (2009). Himachal Pradesh. Souvenir, 60th International Executive Council Meeting and 5th Asian Regional Coference, New Delhi. Organized by Ministry of Water Resources, GOI :110-1.

Anonymous (2009). Water Resources of India : Status and Prospects. Water Resources Development in India. Indian National Committee on Irrigation and Drainage, MOWR, GOI, New Delhi :13-4.

Anonymous (2009). Plan Outlay. Economic Survey, Economics and Statistics Department H.P. Kusumpti, Shimla :23-5.

Anonymous (2009). Water Resources Map of India. Indian National Committee on Irrigation and Drainage. MOWR, GOI, New Delhi 110066.

Anonymous (2011). Economic Survey 2010-2011. Economics and Statistics Department, Department of H.P. Kusumpati, Shimla H.P. :73-6.

Datt Ruddar and KPM Sundharam (2007). Natural Resources, Economic Development and Environmental Degradation. Indian Economy. S Chand & Co Ltd., Ram Nagar, New Delhi :99-100.

Mishra, Anupam (1998). Aaj Bhi Kharen Hain Talab. Prayvaran Kaksh, Gandhi Shanti Pratishthan, 221, Deen Dayal Upadhyay, Marg, New Delhi :98-108.

Randev A.K. (2005). Impact of Irrigation on Productivity and sustainability of Agrolandscapes in H.P.-India. 19th conference at Beijing, China. International Commission on Irrigation and Drainage. CD ROM :1-13.

Randev A.K. (2006). Economics of Drip Irrigation System in orchards of Himachal Pradesh – India. 7th international conference held at Kualalumpur, Malayasia, CD ROM ;1-12.

Randev A. K. (2007). Socio Economic interactions among multiple uses of water in H.P. – India. 4th international conference at Sacramento, California, USA CD ROM :1-13.

Randev A.K. (2008). To Study the Total Factor Productivity of Apple orchards in H.P. MM(1) (Phase I). The Nodal Officer MM-1 (HP) Central Potato Research Institute (ICAR), Shimla H.P :12-61.