ISSUES ON SYNERGIZING OF IRRIGATION WITH DEVELOPMENT OF RURAL AND URBAN INFRASTRUCTURES IN HIMACHAL PRADESH-INDIA

A.K. Randev* Uma Randev**

ABSTRACT

There has been an increasing water scarcity with increasing number of it's users and uses. There has not been an absolute scarcity of water only the relative scarcity exists due to improper management of available water. Dire need is to plan irrigation with simultaneous development of related infrastructure. This paper focuses on (i) inter-linkages among agencies involved in implementation of irrigation (ii) various issues on synergizing of irrigation with development of infrastructure (iii) measures for increasing economic irrigational efficiency. An economic analysis through econometric and scoring techniques reveals significant contribution of agencies in developing irrigation (4.4 times) in the country since independence. Similarly net area sown by different agencies in Himachal has been found 11 per cent of total geographical area. Crops' productivity has been found 2.43 times higher on irrigated lands. Various issues of synergistic approach of irrigation have been grouped into psychological, educational, social, economic, institutional, technical, environmental and financial groups. Economic issue has been dominating, for higher productivity has been an outcome of increased irrigation potential to about 15 per cent more area in the past decade. Higher productivity levels under flood and 30 -79 per cent water saving in fruits, vegetables and flower crops under drip irrigation system have been indicating higher irrigational efficiency. Interactions among various issues have been ratifying still 'higher levels of efficiency' if synergizing of irrigation programs with infrastructural development like construction of irrigation channels, roads, water harvesting structures and vegetative measures etc. is planned by inter-disciplinary experts with proper budgetary allocations. This synergistic planning based upon related issue parameters is 'a must' for balancing, to some extent, hydrological cycle and bringing a balanced growth of the area with irrigation as a 'pivot' through equality between demand for and supply of water for various activities in rural and urban areas.

SUMMARIES AND CONCLUSIONS

Water has been considered as the most essential input amongst all natural resources for it provides utility to all other living and non-living resources so as to transform them to utilizable products. The relative scarcity of water can be minimized by

*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

**Principal, LBS Govt College, Saraswatinagar, Jubbal tehsil, Shimla, H.P. – India

planning water resources on scientific lines. Knowing the facts of inelastic supply of water from ‘nature’ and elastic demand from users side a dire need of planning irrigation with simultaneous development of related infrastructure in rural and urban areas has been felt. This paper focuses on inter-linkages among agencies involved in implementation of irrigation, identifies issues on synergizing irrigation with development of infrastructure and finds measures for increasing irrigational efficiency by adopting suitable economic and statistical tools. The results reveal various state departments have been provided funds for developing irrigational potential in the state and about 10 per cent of the total plan outlay ($ 570m) has been spent on developing irrigation and flood control measures which has been found to be double than the outlay of 1998-99. Consequent upon more outlay and works undertaken by the departments irrigational potential utilized in the state has been reported to be about 82% of the total potential created. The stage of ground water development has been found to be 30 %. Research studies on water resource have revealed a gap of about 76 per cent between demand for and supply of water with respect to top priorities of domestic and irrigation on per hectare per household basis. Positive impact of irrigation on crops’ productivity (as 2.3 times more yield if adequate quantity of irrigation provided) and cost effectiveness of drip irrigation system in the orchards with respect to water saving (66%) and enhanced yields (35% more) have also been revealed. In spite of required rain fall (about 121 cm/annum) for good production of apple crop during a period of 2 decades, productivity differential between 1 to 53.3 kg/tree has been reported due to non availability of water at required period of 4 growth stages of apple. As a result of climate change water availability has been reported to be irregular. Irrigation development index has been worked out to be 0.46 showing a huge gap between weighted and field level irrigation development indices which can be increased provided various issues like psychological, educational, social, economic, institutional, technical and environmental specified for synergizing irrigation with development of infrastructure in rural as well as urban areas are taken care of at every stage of integrated water resource development projects. Essentials of water resource development project include setting trade offs to ensure participation of each activity/sub activity, setting pivot of the project and specifying other related branches i.e. multi objective planning with multi disciplinary experts, specifying demand for and supply of water and especially in water related project under climate change involvement of foresters have been given utmost importance. This strategic paper has highlighted the steps to achieve a balanced growth of rural and urban areas needed for healthy environment at micro as well as macro levels. Consequently joint actions of various departments under integrated water resource development projects can ensure higher level of irrigational efficiency as 92 per cent of utilizable water goes to agriculture sector. Although economic issue has been dominating (higher benefit cost ratios) as prime objective of the beneficiaries has been to maximize net profits on account of enhanced crops’ productivity an outcome of increased irrigational potential to about 15 % more area in the past decade, yet combination of all the issues under the cyclical role of water among various uses can bring a balanced growth in the command area through synergistic approach. Imbalances in hydrological cycle have been observed to be reverted if foresters can work out number of plants per unit of living organism (i.e Animal/plant ratio) responsible for CO_2 emissions which are further responsible for rise in temperature. Specific role of foresters can be specified in at least water resource, road or buildings construction projects, so as to maintain a balance of water plus environmental parameters between urban and adjoining country side.

INTRODUCTION

Water has been considered as the most essential input amongst all natural resources for it provides utility to all other living and non-living resources so as to transform them to utilizable products. There has been an increasing water scarcity with increasing number of its' uses and users. There has not been an absolute scarcity of water only the relative scarcity exists due to improper management of available water while conserving and utilizing water amongst various uses. Economist J.M. Keynes view of 'one's success is one's failure too' holds true, in case any natural resource during developmental activity shows reverse trend in relation to it's existence. Water scarcity with the passage of time has become evident as per capita availability of water has declined by 65% during the last about 5 decades i.e. between 1951 to 2007 (Anonymous 2007). This has been observed only due to ever increasing demand for water with the advancement of technology whereas supply of water from 'nature' has almost been inelastic over a period of time.

India the 7th largest country in the world, due to large spatial and temporal variability in the rain fall receives about 4000 billion cubic meters annual precipitation. The average annual run off in the rivers of the country has been assessed as 1869 BCM comprising of surface water about 690 BCM and renewable ground water about 431.8 BCM, beneficially harnessed through available technology, which supports about 17.1 % of the world population (Anonymous 2010). An annual exponential population growth rate has been found to be 1.95 % (2001) which has been putting more pressure on meager land and other natural resources (Rudder Dutt et.al. 2007).

Himachal Pradesh located between 30o22' and 33o12'N latitude and 75o47' and 79o4' East latitude comprising of 4 agro climatic zones with an altitude range 350-7000 meters above mean sea level receives 180 to 3000 mm of rain fall. In spite of good rain fall about 20 per cent of the total cropped area is irrigated and the problem of water scarcity has been assuming crisis proportions with growth of cities and increasing urban/rural population leading thereby to rising demand for water for irrigation, domestic consumption, power supply, industrial use and navigation etc. Knowing the facts of inelastic supply of water from 'nature' and elastic demand for water, the role of management of water resource, so as to match demand for and supply of water in inhabited areas, has been considered imperative. Hence a dire need has been observed for planning irrigation with simultaneous development of related infrastructure in rural as well as urban areas.

OBJECTIVES

(i) To highlight inter- linkages among agencies involved in implementation of irrigation .

(ii) To identify various issues on synergizing of irrigation with development of infrastructure.

(iii) To work out measures for increasing economic irrigational efficiency.

MATERIALS AND METHODS

Sample has been drawn from Shimla district by adopting purposive and multi-stage stratified random sampling. The size of the sample has been 100. 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.

$$MUw1/p1 = MUw2/p2 = MUw3/p3 \text{ ------------------ } MUwn/pn.$$

Objective (3) has been analyzed by adopting natural system assessment with economic valuation methods through scores. To find out interactions among water, socio-economic and other environmental parameters flow diagram has been used by logical approach such that :

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

Flow diagram has taken into consideration 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 are needed to affect hydrological cycle significantly through creation of water harvesting structures and growing vegetation in a balanced manner. The water utilization aspect requires balanced demand and supply- activity wise. Irrigation development index (IDI) has been obtained by dividing total input index by total output index On various issues of synergistic planning, indices were developed on the basis of problems faced by the orchardists, govt interventions and scientific/logical approach. Irrigational development index indicates cumulative impact of efforts rendered by concerned agencies to develop irrigation potential.

RESULTS AND DISCUSSIONS

Results and discussions have been grouped into two :
(A) Existing status of irrigation (B) What ought to be ? or Optimum status for balanced growth.

(A) EXISTING STATUS OF VARIOUS AGENCIES INVOLVED IN IMPLEMENTING IRRIGATION PROGRAMS

A.1 Development scenario

The land has been found to be inelastic, therefore, growth in crops' productivity in general has been considered possible through realizing higher crop yields which depends upon irrigation. Water resource potential of different river basins of India has been reported to be 1869.4 BCM and utilizable water only 1175 BCM consisting of surface and ground water to the tune of 690 and 369 BCM along with returns from irrigation equivalent to 90 BCM (Anonymous 2010).

Indus and Ganga river basins constitute about 32 per cent of the total water resource potential of India and main tributaries of Indus and Ganga amongst others are Chenab, Ravi, Beas, Sutlej, Yamuna and Tons which flow through Himachal before entering into plains. In the state of Himachal Pradesh, total plan outlay in 2009-10 has been reported to be Rs. 2700 crore (About $570 m) which has been found about 87 % higher than the outlay approved for 1998-99. The plan outlays amongst various heads of development has shown an increase of about 119 % specifically for irrigation and flood control over 1998-99 **Table-1**. Similarly 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

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 provided funds for developing irrigation potential in the state like department of Public Health and Irrigation, Rural development, Agriculture, Horticulture and Forest **Table-2**. It has been found that 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 and the programs/schemes undertaken by different departments, the ultimate water resource potential in Himachal Pradesh has been reported to be 3.53 lac hectare and potential created up to tenth Five Year

Plan has been found to be 2.63 lac hectare (75 % of the total potential) including 0.50 lac hectare cultural command area (CCA) under major and medium irrigation projects and 3.03 lac ha under minor irrigation projects.

Table-2 Various development departments of the state and programs of water resource development

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 has been reported to be 82 per cent of the total potential created which has been found to be greater than the national average of 74 per cent., but ground water development has been found 30 per cent less than national average of 58 per cent **Table-3.**

Table-3 Ultimate irrigation potential and potential created and utilized in H.P. vis-à-vis India **(‘000 Ha)**

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

* **Irrigation potential utilized** **** percentage**

In Himachal Pradesh about 12 per cent area of total geographical area of the state has been reported to be the net area sown and about 20 per cent area of total area sown has been found to be irrigated. The net irrigated area through minor irrigation schemes like canals, tanks, wells/tube wells and other sources has increased by about 6 per cent between 1998 to 2007 and their number has increased by 29, 172, 38 and 0.40 per cent respectively during the same period. The maximum area has been found to be irrigated by other sources i.e. kuhls about 80.90% followed by wells and tube wells (14.63%), canals (3.81%) and tanks (0.65%) of the net irrigated area. As a result of an increase in irrigated area on account of developmental efforts, area under apple and vegetables has increased from 85631 to 94438 hactares (about 10%) and 33240 to 58743 hactares (77%) during 1998-99 to 2008-09 respectively. At the same time increased irrigation potential utilized has added to crops' productivity benefiting directly the farmers. MOSTLY ALL THE CONCERNED DEPARTMENTS HAVE BEEN UNDERTAKING WORKS INDEPENDENTLY IN ISOLATION AND CONTRIBUTING TO THE TOTAL IRRIGATIONAL POTENTIAL.

A.2. Research scenario

A.2.1 Relative scarcity of Water

At the existing level of water use it has been found that water has not been managed properly to bring equality between demand for and supply of water available, whereas demand for water among various uses has been found 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 requirements of water has been found to increase by 34 per cent (813 to 1093 BCM) by 2025 in the country (Anonymous2009).

A.2.2 Gaps in water availability

Socio-economic interactions among multiple uses of water in the state has revealed 76 per cent gap between demand for and supply of water with respect to top priorities of domestic and irrigation on per hectare per household basis.

A.2.3 Water Resource use impact on crops' productivity

The results of various research studies undertaken by the author in have revealed positive effects of irrigation in enhancing crops' 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 increasing number of population (Randev, 2005) which has been clear from the following yield equation :

$Y = 6.0417^{*} + 1.3198\ x^{**} + 0.6627\ x\ 2$

S.E. (1.1543) (0.7667) (0.1105)

tc = 5.23 1.72 6.03 $R^2 = 0.9731$, * significant at 1% probability level and ** at 5 %. A difference between 3 and 6 number of irrigations has been estimated as on the average 3 times rain water was available during the study period.

A.2.4 Cost effectiveness of micro irrigation systems

Similarly dire need of water in its' multiple uses has enforced nations to give top priority to water saving technologies. An economic study on drip irrigation system in orchards of Himachal Pradesh (Randev A K 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. Environmental parameters at micro level indicate higher significance of literacy which gets affected due to ultimate return to the family by the adoption of any new technology successfully. This has also been found directly related with the enhancement of skill by increasing grasping. With the expansion of literate population, magnitude of literacy has to be considered implicit in itself in the light of welfare of an individual. The economic issue has been found dominating for higher productivity has been an outcome of increased irrigational potential to about 15 % more area in the past decade. 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.

A.2.5 Impact of climate change on water availability

An economic study on impact of climate change on apple productivity in Himachal Pradesh has revealed as amongst all the weather parameters, temperature has been found to be a pivotal factor, controlling the occurrence of other parameters through controlling hydrological cycle in micro as well as macro locations. Over all difference in the range of annual maximum temperature has been found to be about 24.41 per cent during the previous two decades (1987-2007) indicating 'warming up of the eco-system' resulting further growth stages-wise adverse variations thereby disturbing chilling requirements as well as flowering and fruit set and growth and development stages. Although temperature has been the major cause yet in physical units, it has been the quantum of water available for use by the plant during critical stages of growth which have been affecting apple productivity either positively or negatively. Month-wise data have revealed 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 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 CROPS' PRODUCTIVITY CAN BE SUSTAINED ONLY IF CROPS GET

WATER AT REQUIRED INTERVALS OF TIME OF DIFFERENT STAGES OF GROWTH OF A CROP, WHEREAS IF WATER AVAILABLE AT IRREGULAR INTERVALS, PRODUCTIVITY VARIATION HAS BEEN REPORTED, HENCE A DIRE NEED OF BALANCING DEMAND FOR AND SUPPLY OF WATER AT A PARTICULAR PLACE THROUGH WATER RESOURCE DEVELOPMENT PROJECTS.

A.2.6 PROBLEMS FACED BY THE ORCHARDISTS

Although orchards have been reared under rain fed conditions, yet due to changing pattern of weather parameters specifically temperature and rain fall supply has been reported to be irregular – a matter of concern influencing productivity. 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).

(B) WHAT OUGHT TO BE / OPTIMUM STATUS FOR A BALANCED GROWTH

In order to achieve a balanced growth in relation to water resource, various issues on synergizing irrigation with development of infrastructure and various measures for increasing irrigational efficiency have been considered.

B.1 Various issues on synergizing irrigation with development of infrastructure

Water being the pivotal element in transforming various living and non- living resources for their use, hence synergistic approach in developing irrigation potential has been considered essential. Various issues have been grouped into the following.

(i) 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.

(ii) Educational

Literate mind grasps, responds and performs better in relation to any sub activity under a project.

(iii) 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.

(iv) Economic

Management of resource structure in order to achieve objectives of the project economic indicators need to be specified in the project, so economic issue (e.g. specification of variables etc.) forms an important aspect of the project. Financial aspect may be dealt within economic issue leading to financial viability of the project.

(v) Institutional

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

(vi**) Technical**

Technical issue comprises of technical knowledge to be used to transform man-made and natural assets into final goods and services..

(vi) Environmental

Environmental issue may be considered as the most important issue as it has been found to enhance all different related parameters constituting environment of the project which may be directly or indirectly related with the direct interventions of the project. 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.

Interactions among various issues

Interactions among psycho-socio-techno-economic parameters reveal individual's attitude (beneficiary in the command area of water resource project) towards developmental efforts in water related projects specifically, which should be positive, imaginative and creative that 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 judicial utilization as opined by about 99 % of the respondents (Randev 2007).

Albeit a large number of projects/programs of water resources development have been implemented and huge investments have been made during various plan periods yet continuous and visible growth has not been possible due to individualistic approach of the departments, strictly 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 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 as (i) drinking (ii) irrigation (iii) hydropower (iv) navigation and (v) industrial and other uses.

In the light of above discussions synergistic approach 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.

B.2 Measures for increasing economic irrigational efficiency

B.2.1 Irrigation development Index (IDI) at the existing level

Interactions among responses of the orchardists with respect to problems faced by them in undertaking orcharding and other socio-economic parameters (Randev 2008), govt efforts to develop irrigation and scientific requirements of water at different stages of growth of apple, in the light of different issues of synergistic approach have been used to develop a weighted irrigation development index and irrigation development index at the existing level of socio-economic parameters Table-4.

IDI at the existing level of resource use has been worked out to be 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. There has been a need to make each individual/beneficiary of water resource development project well conversant with the multi objective role of the project and seek one’s response in creating viable solutions in planning. Individual behavior has been seen to be sharpened through ‘education’ followed by social, economic and technical issues. 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

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	12	4
	TIDI	1.00	0.46

Water an economic commodity can be put to many uses as prioritized in the national policy too. Although a dominant share (about 92 %) of utilizable water goes to agriculture hence through increased irrigational efficiency at the existing level of water use crops' productivity can be increased by 2-3 times. But cumulative efficiency (i.e. smaller the cost more efficient the process) of water resource project amongst various uses of water can still be 'higher' through synergistic approach because scale of economies are set-in in case of integrated water resource development projects with multi-objective purposes. This can be achieved by passing through the following steps.

B.2.2. Steps for enhancing irrigational efficiency

(i) Setting Trade offs to ensure participation

Intra- agency and inter-agencies participation 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.

(ii) Setting pivot of the project and specifying other related branches priority wise i.e. 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

Flow chart -1 CYCLICAL ROLE OF WATER

(iii) 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.

(iv) Special mention if any

In integrated water resource development (IWRD) projects, role of vegetation has been found to be of utmost importance - like role of a forester.

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 C02 EMISSIONS WHICH ARE FURTHER RESPONSIBLE FOR RISE IN TEMPERATURE.

SECNDLY 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.

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).

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.

CONCLUSIONS

1. The relative scarcity of water steers to plan water in a scientific way by adopting multi objective planning.

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.

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.Synergistic planning 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.

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