GROWTH-POTENTIAL OF PAKISTAN'S WATER-RESOURCES AND THEIR IMPACT ON DEVELOPMENT

*Malik Muhammad Nazeer**

ABSTRACT

Pakistan has ideal and matchless God-gifted resources for its own overall development and a very decisive role in grabbing the earth globe out of the mouth of twenty-first century's environmental dragons, ready to swallow the entire life on it. Its location on the globe and its geographic position in the subcontinent, having the world's highest and biggest snow glaciers, containing the mountains, Himalayas and Karakoram, along with special pattern structure of mountain-wall on the north and the Indian Ocean, bay of Bengal and Arabian Sea around the Equator, led and followed respectively by largest recipients of solar-heat, the continents of Australia and Africa, on the its south has no match throughout the world. The mechanism having above- stated component parts causes heavy monsoon rains.

A sizeable share of these rain waters is received by Pakistan, which has the potential to store all or most of this water and use it not only for its agricultural and power requirements, but also for safely leading the world out of the crunching grip of environmental dragons of twenty-first century. Before highlighting the role of Pakistan in ameliorating deadly Global issues of exponentially rising global warming, environmental pollution, hole in the stratospheric ozone layer, droughts and resulting social and economic problems, it is worthwhile to properly estimate the size and mechanism of its resources and their direct impact on its local development. This aspect is fully discussed in the present work, as a preface to its real and ideal roles, which will be highlighted in the subsequent attempts.

INTRODUCTION

The earth's rotation, supported by the enormous amounts of solar energy received by Australia and Africa with large temperature and pressure-gradient between these main-lands and the Oceans, produce large wind currents, resulting in monsoons which carry water-vapors from the Indian Ocean, Bay of Bengal and the Arabian sea towards the Indian sub-continent. The high Himalaya mountains in the north of the sub-continent and the Karakoram range in the north-west of Pakistan enable these winds to form loops and discharge water-contents, as rain, and provide huge water-storage for the sub-continent in the form of snow. Although Pakistan is very lucky to have numerous dam-sites to store large quantities of this two-to-three month supply of monsoon rain-water and regulate it for its perennial irrigation and electric power generation purposes, but unfortunately these water-resources are not being fully utilized. Proper planning and execution could help increase the water-resources more than twice, the agricultural product by four to five times and hydro-electric power-generation capacity by a factor of about ten. These resources, their location, their size and mutual compatibility, when viewed in the perspective of Pakistan's development and particularly in that of global challenges, at once bring into mind the position that Nature has intentionally created this entire system for the (complete) solution of Mankind's deadly problems of 21st Century. The system is ready to work, but it needs the effort of Mankind to start it. Its starting key, however, is the well planned construction of its water-storage, power-generation, irrigation and drainage systems, and Mankind has to do it collectively at any cost, putting aside all the differences, whatsoever, for its safe existence on the globe. Naturally, the industrial countries and producers and user of fossil fuels have a large share in contributing to and fuelling the global problem and they should, accordingly, be the major contributors of the cost involved in remedial operations. The UNO have the opportunity to do the most-wanted role of planning, supervising, financing this activity and collection of the due contributions.

MECHANISM OF WATER-RESOURCES

The rotation of the earth about its polar axis at a speed of about 1000 mph, exerts centrifugal force on the atmosphere, which along with its vertical component are zero at the poles and maximum at the Equator, while its horizontal component, directed towards Equator, is maximum at 45° latitude, but zero both at poles and Equator, as shown in Fig 1(a.b.). The horizontal component of centrifugal force pushes the winds towards the equator on the surface of earth

* Dr. A.Q. Khan Research Laboratories, P.O.Box 502, Rawalpindi.

and the solar-heat forces it towards the poles in the upper atmosphere. In summer, this movement is further amplified by the solar heating difference in the two hemispheres, due to 66.5° inclination of the earth's polar axis to the plane of its rotation around the sun. Therefore, during the summer, the winds in the form of Monsoon are forced from Indian Ocean and Bay of Bengal to Indian sub-continent [1,2] by the temperature difference of the two hemispheres, and by pushing of the East African ridges and directing the dragging air, due to spinning of the earth about its polar axis. Their post-equator route is mainly through the Bay of Bengal, directed by the earth's polar rotation[3]. These winds are further redirected towards Nepal and northern areas of Pakistan, particularly the Kashmir region, by mountain-wall of Himalayas and Karakoram on the north of Indian subcontinent (Fig. 2). The Pattern of these mountain-ridges [2,4] gives rise to local cycling of the Monsoon winds, causing rain in Bangladesh, India and Pakistan. Guided by northern and north-western mountain wall, augmented by the horizontal component of centrifugal forces (due to earth's rotation) and further directed by land and sea trading across Indian sea-shore, the cycle is completed across Pakistan, Iran, Saudia and Ethiopia onward. The Equatorial areas of Africa and Australia provide necessary heat-energy to these winds for their water- vapour charging from the Indian Ocean.

In winter, low pressure is developed behind the Himalayas, due to the earth's spinning, by the trading of the winds between the earth's hemispheres and due to different solar heating effects on land and sea. This forces the Eurasian, Mediterranean and Caspian sea winds to follow the route shown in Fig. 2, which give rise to local winds counter-clockwise circulation [5] in and around Punjab. For the rest of the year, the winds normally creeps from south to north and are guided by the mountain-ridges towards Kashmir. Except the Monsoon, the winds are normally dry, and their main source of feed for rain and snowfall is local evaporation of water from rivers, lakes, irrigated land and plants, as shown in Fig. 2,. Thus, more supply of water to irrigated area will result in more rain and snowfall during this dry season.

The scenic situation of Australia and Africa on the two sides of Indian Ocean, around Equator; a smooth passage of Bay of Bengal and the mountain enclave, with special guiding-pattern on the north of Subcontinent, for guiding, tracking and de-watering of the generated monsoons; one of the longest perennial rivers Indus, with a number of feeding tributaries and large snow-glaciers of World's highest mountain-ranges and with number of large deep valleys for storage Dams; large fertile planes with suitable natural slope located at very suitable latitude for availability of required solar heat; worlds largest solar-heat reservoir-Africa and Middle east - at its south west and special local and global wind routes; all this makes Pakistan, ideal and matchless throughout the world.

LOGIC BEHIND PAKISTAN'S WATER STORAGE CAPACITY

The main contributor of Pakistan's water resources are the Indian ocean, the Arabian sea and the Boy of Bengal in the Monsoon season(Fig. 2). The evaporated water from these regions is carried by winds towards the Himalayan ranges and then is directed westward. This brings heavy rains and snow in the north and northwest of Pakistan.

It is estimated [6] that Pakistan has annually an average of 143 (Min.110,Max.180) MAF(Million Acre Foot) water-flow capacity. About 30 MAF flows from September to May, while the rest of 113 MAF flows generally in the peak rainy season from June to August (Fig.3). If the irrigation system is fully developed to use all the 143 MAF of available flow of water, even then the irrigation demand during peak-flow season, as shown in Fig. 3, can hardly be 25 MAF instead of 36 MAF because of the local heavy rains. Under these conditions, about 88MAF of water will be available for storage. The water-storage system should, however, be designed for the maximum water- flow rather than for the average flow i.e. storage capacity should accommodate about 135 MAF (180-30-25). The water-storage capacity of existing dams is only 13 MAF, i. e. 8 MAF of Turbela and 5 MAF of Mangla. Therefore, about 77 MAF based on average and 122 MAF based on Maximum flow, could further be stored, which at present flows down to the Arabian Sea.

POTENTIAL OF GROWTH IN WATER-RESOURCES OF PAKISTAN

The second main contributor to source of water is Pakistan's irrigation system (Fig. 2 & 3). About 80%of

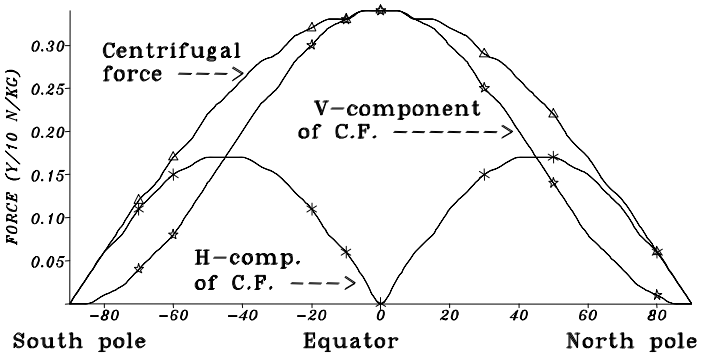

Figure - 1(a): Centrifugal force due to earth's rotation and its vertical & horizontal component along a longtitude

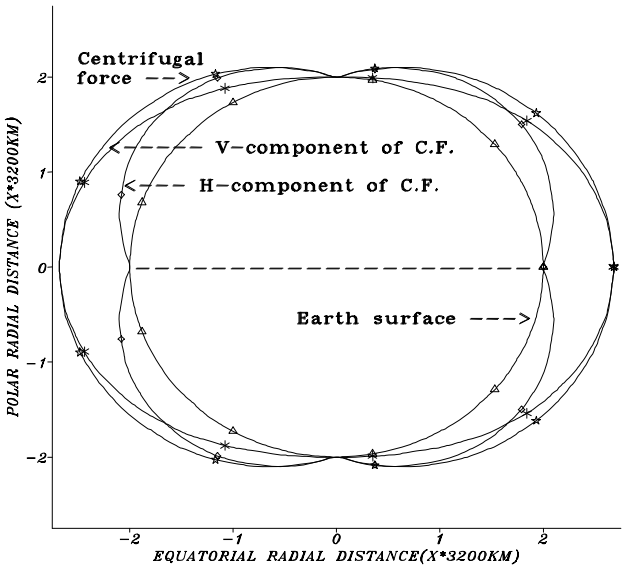

Figure - 1(b): Centrifugal force due to earth's rotation and its vertical & horizontal components

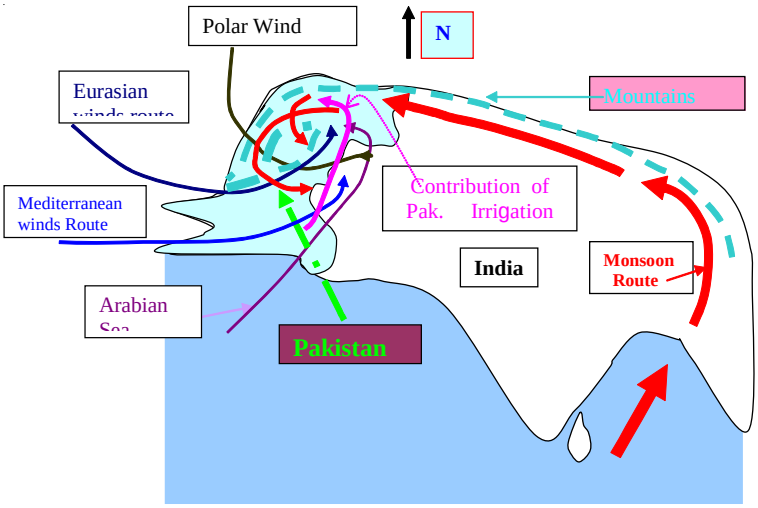

Figure - 2: Wind routes in the subcontinent and especially across Pakistan

62 MAF (30+13+19) of water, which is presently fed to the agricultural lands, as shown in Fig. 3, evaporates and about 80% of this evaporated water falls back in the form of rain and snow in the catchment areas of Pakistan's rivers. Therefore, about 40MAF out of 143 MAF available flow is due to the feedback contribution of 62 MAF, which is being used for agricultural purposes. If all the 143 MAF could be used for agricultural purposes, then the local contribution to rain and snow could be increased from 40 MAF to above 92 MAF i.e. the 143 MAF available quantity of water could be increased to more than 195 MAF. An iterative computer model, based on the average flow, as presented in block diagram of Fig. 4 shows that water resources can be increased from 195 to 250 MAF, if 110 MAF water-storage and corresponding irrigation system is properly developed and the drained underground water is re-circulated (Figs. 5 & 3). It

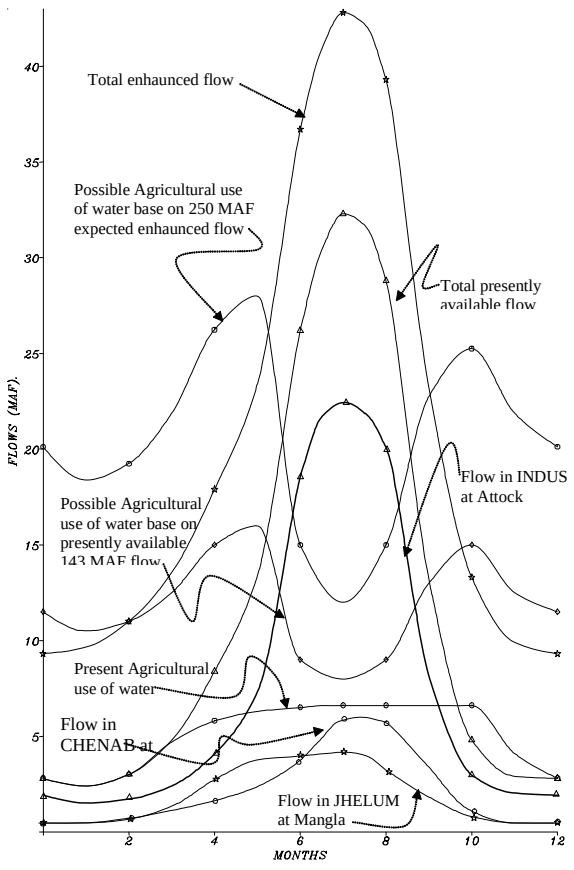

Figure - 3: Present and predicted water-flow in Pakistan rivers and its present and ultimate irrigation usage, based upon both available and predicted flow

will be very interesting to note that, due to ideal environmental location of Pakistan, the local contribution to the flow-resources is quite reliable, as compared to the global contribution, and thus the development in this field will minimize the fluctuation of flow as well.

As is shown in graphs of Fig. 5, with 110 MAF storage capacity, the requirement of irrigation and drainage recycling system handling-capacity is 330 MAF and it will yield 85MAF of local rains, 145MAF feed to flow- resources by local recycling, with 250MAF net flow resources. Thus, the development outlined above will result in tremendous growth in the water-resources of Pakistan, with ideal solution to a number of extremely critical local and global issues. If an optimum storage, irrigation and drainage system is developed, all the enhanced available water-flow may well be utilized for irrigation and all of it will have to be evaporated to avoid water-logging-of course, the absorbed quantity will have to be extracted through drainage- system and forced to evaporate indirectly (through re-circulation) or directly (using barren lands) for blocking the global warming and for its maximum utility in growth of water-resources.

STORAGE EFFECTS ON AGRICULTURE

The country's agricultural output is based on 62 MAF (80 MAF, including local rains) feed of water. With the enhanced resources of 330MAF(370MAF), the irrigated area may increase 5 times, with sufficient supply, and hence the agricultural output may well increase up to 7 times. All the remaining plains area of Pakistan (may it be southern Frontier, may it be southern and Northern Punjab, may it be eastern, southern and western Sind or may it be all the plain area of Bluchistan) may quite sufficiently be irrigated and it may provide the matching part-the area required by the proposed system to be irrigated. The resources, when fully developed, could even enable Pakistan to sell it's extra water to India for its irrigation of Rajistan area.

STORAGE EFFECTS ON HYDRO-POWER

The quantity of water available and its gradient are the two important basic factors for hydro-power generation. God has gifted Pakistan with both of these factors, adequately. At present, it is being largely

wasted. Most of the available water (143 MAF) flows down from a height of about 7000-8000 ft.[5]. Pakistan is also very lucky to have many reservoirs and dam-sites along its rivers Indus, Jhelum, Kabul, Swan and Hero, which could be used for storing and regulating water for irrigation and power-generating purposes. Some of the dam sites are Skardu, Kalabagh, Bhasha, Chillas, Dasu, Gilgit, Dhoke Abbaki, Dhoke Pathan, Geriala, Mukhad, Azad Pattan, Mong Rasul, Sehwan Mansher, Chitral and Thal. These dams could store and regulate the water-flow for agricultural and power-generating purposes, over a long period; but to achieve this goal, bold and wise steps need to be taken as early as possible. The average water-head for 143 MAF is about 5,000 ft. Therefore, an estimated peak power-generation capacity would be 5000X143 or 715000 MASF (Million Acre Square Foot). If 50% of this could be feasible, due to technical reasons, even then Pakistan could generate 360,000 MASF (42,000MW) of hydro-electrical power. Presently, only 62 MAF with an average head of 500 ft. is being utilized for power generation, i.e. 62X500 MASF or about 3,600 MW, which is only about 9% of the total capacity. Therefore, with proper development, upto 10 to 12 times enhancement in the present hydro-power level could

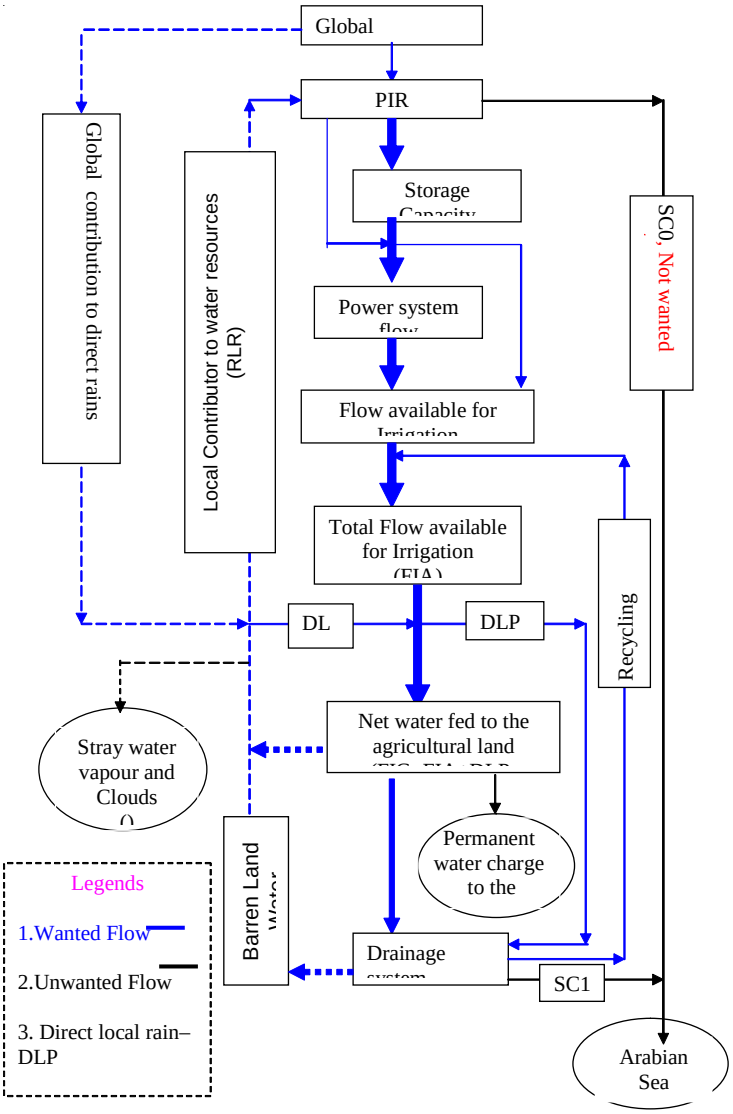

Figure - 4: Suggested Water-Cycle of Pakistan and Block Diagram of the Computer-Model

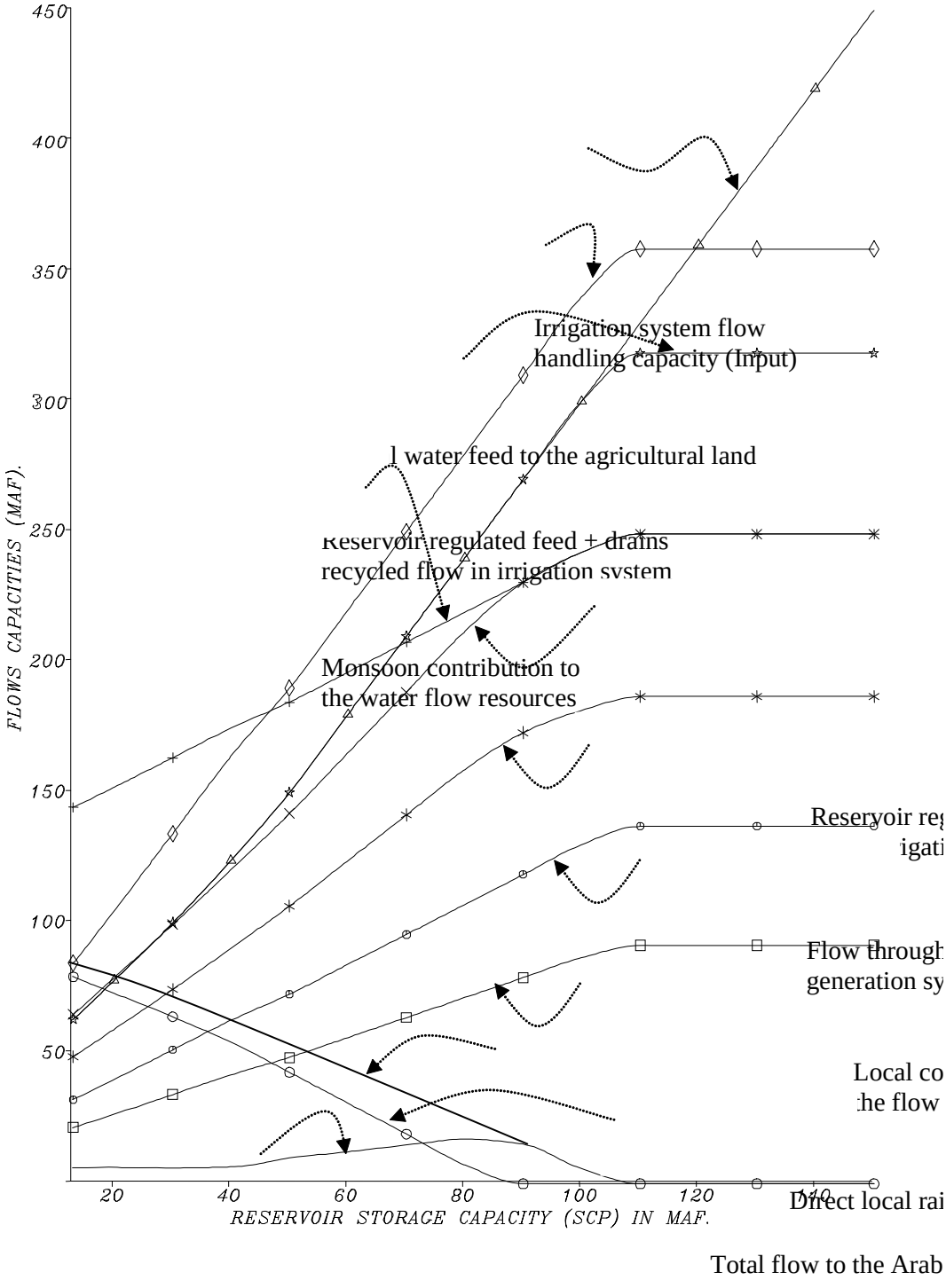

Figure - 5: Reservoirs Capacity Effect on Related Flow Quantities

well be achieved. It is suggested that, in the first stage, 10 to 12 dams with sufficient storage and power-generating capacity should be constructed, to meet the country's present power and agricultural demands.

Unlike costly petroleum, oil, gas, and coal sources, water is not consumable and is available free of cost; also running cost of hydro-electric plant is low, as compared to other sources. This is why the hydro-electricity is much cheaper, as compared to petro-chemical or nuclear power. Moreover, there is no risk of source-exhaustion, atmosphere pollution; and it is free of any radiation hazards. This will also result in producing a well regulated supply of all the available water to the irrigation system and would be a great help for the economic stability of Pakistan, by boosting the agricultural and industrial output and employment, by creating new opportunities in agriculture, industry, power and irrigation sector.

RECOMMENDATIONS

In order to get full benefit of the water-resources, Pakistan has got to develop its own missing-link in the water-cycle shown by thick blue lines in Fig. 4, i.e. to develop adequate storage, irrigation, power-generation and water-drainage systems. Even the wastewater should be forced to follow the thick blue dotted route (Fig. 4), using the barren lands at the downstream side. In order to achieve this goal, sufficient funds, machinery, materials, manpower and expertise are locally available or can possibly be made available through UNO, by highlighting its impact on the terrible global issues of earth's heating, pollution, ozone-layer depletion, petroleum exhaustion and tremendous rise in oceanic levels, etc. Therefore:

Firstly, the overall Planning for surface-storage of available water for power- generation, irrigation, and flood-control, with its time-bound execution, should be started. This planning should be done with mutual cooperation between related departments and should be based upon thorough objective study and analyses of overall aspects, results and consequences.

Secondly, the Execution-Phase should immediately be started for the projects already designed and awaiting execution, like the KALABAGH DAM. If this sector is developed with well-organized planning, not only power and agricultural output of the country, but also aqua-cultural and industrial output will be boosted many times.

Thirdly it should be pointed out here that **multipurpose Large dams are vital**, very cheap, both in construction and in operational cost per unit of their output. It is childish to talk of small dams in comparison with these, just like accepting a number of very beautiful and cheap small cars against an actual Mercedes car. Also, **reclamation of additional storage-facility, by raising its hight further, in the existing dams is extremely dangerous,** and government should **refrain** from it, until and unless 3-4 non-military organizations, expert in design of dam and allied critical facilities, should thoroughly analyze the initial design independently and all confirm its feasibility. After all, it is a multi-billion dollar costly dam designed and constructed only for the present maximum water-level and also involves question of life of millions of peoples living down-steam. The de-silting like that of large harbours may rather be considered and the collected silt may be downloaded in the dead volume pockets or in the side-valleys, reclaiming these for agriculture.

KALABAGH Dam Vitality: The multipurpose KALABAGH dam is vital for southern Frontier and Bluchistan irrigation and very cheap, very easy in construction and has number of merits, as compared to its sisters other dams, as stated below.

In view of additional 97 MAF storage requirement, all the possible dams need to be constructed and Pakistan should start several of them, in parallel, as much as its resources so permit. Thus, within 2-3 years, 4-5 dams may be in various phases, one after the other, utilizing the same "men and machinery phase-related resources" successively on various dams. Hence, there is no tie in between any two or three sites what-so-ever. Kalabagh, **a multipurpose dam with irrigation and flood-control priorities**, has many merits and its priority-construction is vital under number of aspects. In this connection, a review of following few points is worthwhile.

i) It have gone through a number of initial phases and is ready for construction right now;
ii) Its storage capacity may be comparable with many other sister dams, yet in power-generation it has no match at all. All the storage of dams

upstream will directly add to the flow through its power-generation turbines, running always at optimum output and, in this respect, it has no match at all. It is not costlier than any competitor, yet, even if it were 4-5 times costly than the competitors, it wouldl soon payoff its whole price within a few years.

iii) Tarbala and Warsak Dams, being upstream, It has little risk of silting or sedimentation and in this respect, it does not have any match too. The de-silting option in this dam construction has no need to be considered. It has additional storable flow, due to its location downstream of rivers Kabul, Swan and Hero.

iv) Adequate supply of Irrigation water to Southern plain area of Frontier province and Bluchistan can be possible only with its construction. It can provide most quick and qualitative control on floods downstream of Kalabagh, due to flood in Rivers Indus, Sawan, Hero and Kabul and in this respect has no competitor.

v) Being right at the neck of irrigation water distribution system, it can relieve Sind and Nothern Punjab of Indian-based flood-damage, by providing most quick, direct and effective control on water-flow management in the irrigation-system and thus enable Pakistan to take irrigational benefits in the above stated areas from these floods too, in place of their damages.It can boost the agricultural output of District Kohat, Bannu, Mianwali, Chakwal, Attack and Mardan, through favourable change in the climate and frequent rains, and has no competitor in this respect too.

vi) Mobilization of construction materials, Machinery and Manpower may be easiest, cheapest and quickest.

vii) Power produced can most easily, quickly and cheaply be brought to National Power Grid systems.

viii) It is at a safe distance from the seismic epi centers and has no match in this respect also.

These aspects make Kalabagh a vital construction and affix it on the top priority. In the real sense, Kalabagh is the lifeline and soul of Pakistan's economic existence and its priority construction is vital in any case.

The controversies over its construction are all of childish standard and mostly baseless and, generally, not directly on Kalabagh, rather on any storage dam.

CONCLUSIONS

Utilizing maximum water-storage would certainly help regulate country's water-needs to increase the agricultural products and make Pakistan self-sufficient in food. This should also increase the Hydro-electric energy, to meet the much-needed demands of electricity which, in turn, helps the industry to grow. It may even turn out that if most of the dam sites available in Pakistan could be constructed to generate Hydro-Power, then Pakistan could even sell electricity. Above all, this will create millions of jobs and could amicably solve Pakistan's ever-rising unemployment problem. If Pakistan's presently available water resources could be fully and properly utilized, then the following results can be achieved;

- Four to five times increase in the irrigation land.
- Six to Seven times increase in the agricultural output.
- Ten to twelve times increase in hydro-electric power.
- Eight to ten times increase in the industrial output.
- Millions of job opportunities.

REFERENCES

1. National Geographic, Vol.166, No.6, (December 1984), p.712-728
2. National Geographic Atlas of the world, Fifth Edition,(1981) Washington D. C. p.18-23.
3. Malik Muhammad Nazeer, Athar Naeem "Role of Earth Shape and Rotation in Generating and Tracking of Cyclones.", Journal of Natural Science and Mathematics, volume 38 No. 1 & 2,pp: 217-227, Lahore, Pakistan, 1998.
4. Phillips Atlas Of The World, second Edition, (1992)p.58,79-81, 122,109
5. KM Shamshad, The Metrology of Pakistan, Royal Book Co., Karachi (Pakistan), (1988) p.60-64
6. P. Lieftinck, A. R. Sandove, T.C.Creyke, Water and power Resources of Pakistan, World Bank Report, John Hopkin Press, 1 (1968) p. 119-123