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EDITORIAL

Drought has got different faces and every one views it from his own angle. In simple terms, drought means low or less rainfall in a year or several years over a certain area, region or pockets. However, causes may be hydrological, meteorological, natural, bio-physical, social or religions. Unlike floods, droughts donot occur all of sudden or without notice but they are mainly the results of men-environment effects and a set of weaker sequences mostly extended and less rainfall. Increasing human activities and over exploitation of natural resources badly effects the weather circle. the severity of droughts may results into the loss of live stock and human beings. the various studies carried out at CAZRI reveals that there is a set pattern of drought in Western Rajasthan. It will start from the north eastern part during the month of June and will spread/shift towards south eastern part of the state in the month of August.

Drought adversely effects regetation, crops, livestock, households, or namets etc. of the villagers and thus spoils villagers economy. During droughts farmers/villagers are compelled to sell their crops, lands and household good at a very cheap rates. Not only livestock but also the human beings migrates during droughts, specially in consecutive second and third years, in near by places/states.

The India has been divided in the four major regions and desert zone has been classified in the western zone of the country. the 72% of the India population live in the villages and about 2,30,000 villages donot have surface water in around 1.6 km radiers. The villagers consume most unhygenic water which is not recommended for even animals. The rainfall variation in the country is unique where Cherapunji (Meghalya) receives about 120 mm rain every year as compared to the Jaisalmer (Rajasthan)about 12 mm a year. the regions prone to droughts are Western Rajasthan, Gujrat specially Kutch and some part of Bihar, Orissa and Andhra Pradesh.

Historically, Jaisalmer faced most severe droughts during 11 century, when it didnot rain for consecutive 12 years. Again during 1348 AD and 1392 AD, the "Thar Desert" faced severe droughts when people of the region survived on raw animal meet. Though, today region has faced many severe droughts and famines, yet, the 'Chappna Kal', 1899-1900 (vikram Samvat 1956) has the worst impact on the people of the area. It was 'Triple Kar' (Trikal) of food, fooder and water in Rajasthan. During this drought 83% area of the region experienced deficient rainfall. The people of the region and time who witnessed this severe drought used to say that no such dreaded famine in the past occured in Rajasthan for the last 100 years. The most ocutely affected regions were Marwar, Bikaner, Mewar, Jaisalmer, Ajmer and Jaipur. this drought was considered as a most unprecendented event. The havoc caused by this famine can be judged from the fact that one million person had starved to death and a large number of survivors were reduced to the condition of moving skeletons.

After 1899, four major droughts in the years, 1979, 1982, 1987, and 2000 occured in the country. the 11 states of the counltry reported to have experienced the recent drought. The severity of the drought can be understood by the fact that about five crore people of the two states- Rajasthan and Gujrat have been affected seriously. The entire livestock population of these two states reported to have faced severe water and fodder shortage. it had become most usual to ssee the heap of dead bodies of cattle population daily on the road sides of the villages.

The idea of better monitoring and accessing drought has been a quest for CAZRI for about five decades. The CAZRI is always advocating for better climatic monitoring. Particularly drought monitoring, rain water harvesting, watershed management and early warning of droughts beacuse drought is a normal, recurring hazard in virtually all parts of Rajasthan.

D.C. Ojha
Editor/P.I.(ENVIS)

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STRATEGY TO COMBAT DROUGHT AND FAMINE IN THE INDIAN ARID ZONE

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During the previous century, the Indian arid zone experienced agricultural drought in one part or the other during 33 to 46 years, which suggests a drought once in three years to alternate year. Often drought persists continuously for 3 to 6 years, as prolonged droughts faced by this region during 1903-05, 1957-60, 1966-71, 1984-87 and 1997-2000. Such prolonged droughts put tremendous stress on natural resources and lead to severe scarcity of food, fodder and water.

The major causes of agricultural droughts in the Indian arid zone are its geographic location not favouring abundant monsoon rainfall, poor quality and excessive depth of groundwater limiting its use for irrigation, absence of perennial rivers and forests, poor water holding capacity of soils, and huge drawl of limited groundwater resources. Because of lack of substantial irrigation facilities, the agriculture is mostly dependent on rainfall. The increased pressure of both human (400%) and livestock (127%) population during twentieth century has put tremendous pressure on land, and surface and groundwater resources. Therefore, the impact of drought is felt much more severely in the arid region compared to other parts of the country.

As the water storage is dependent on the scanty and erratic rainfall, the duration of availability of water in surface water resources is reduced significantly in drought years. Groundwater table is declining @ 0.2 to 0.4 m/annum in almost three-fourth of the region, consequently shallow wells dry up during droughts and deep wells became deeper. Quality of groundwater deteriorates and sometimes the concentration of undesirable substances such as fluoride and nitrate increase to harmful/toxic levels. Grazing herds of animals quickly remove the scanty grass cover that come up with meagre rainfall, thus aggravating the problems of soil erosion and desertification. Widespread crop failures lead to acute shortage of food and fodder. Both human and livestock suffer from malnutrition and consequently become victim of host of diseases. As most of the people of this region depend on agriculture and pastoralism, drought leads to decline in income and employment opportunities. Large-scale migration with livestock or in search of employment is a common feature during prolonged droughts.

To minimize the suffering of human and livestock, relief measures are taken up by the respective State Governments and NGOs' on a large scale. These measures mainly aim at provision of drinking water, supply of food grains through Public Distribution System at subsidized rates, supply of feed and fodder for livestock and subsidy to approved Gosalas, human and livestock healthcare, etc. Efforts to create direct and indirect wage employment through food for work barely sustain the living of the rural poor who suffer most due to drought. However, some long-term preventive measures need to be given increased attention for integrated development of drought-prone areas and to tackle the problem on permanent basis. Some of these direct measures are long-term forecast of monsoon, suitable land use system, water harvesting, soil and water conservation, contingency crop planning, adoption of improved technologies for dryland crops, efficient irrigation methods, enrichment of cereal straw as fodder, etc. In addition to these, human and livestock population pressure needs to be reduced through education, alternative ways of employment generation and disposal of unproductive livestock.

The root cause of weak monsoon in India is related to the widespread, persistent atmospheric subsidence, which results from the general circulation of atmosphere. Better understanding and mathematical modeling of the monsoon phenomenon would be very helpful in early long-term forecast of monsoon to enable planners and farmers to plan accordingly.

No one understands the value of single drop of water better than the desert dwellers. Rainwater harvesting is traditional way of life in arid regions. Various techniques of rainwater harvesting have been developed/refined by research workers. Improved designs of Nadis, Tankas, Khadins, etc. have also been developed. These technologies should be popularized among the people of this region. Utilizing flash floods/surplus rainwater for artificial recharge of groundwater to augment the dwindling water table is need of the hour. Integrated watershed management, which aims at utilizing the rainfall wherever it falls should be the unit for planning and implementation of the development programmes. The measures like afforestation, pasture development, livestock management, field crops, water storage, etc. are undertaken in the watershed areas identified as suitable for such measures.

With the increased pressure on land, marginal lands are being brought under cultivation, which is a disastrous trend. Concerted efforts have to be made to adopt suitable land use systems keeping in consideration the rainfall, soil type and need of the people. Growing of crops, fruits, trees and grasses in various combinations minimize the risk of crop failure and provide stability to farm income. Suitable combinations of these components for different rainfall zones and soil types have been developed by CAZRI Scientists which should be preferred over crop cultivation alone.

As water is the scarce resource in the Indian arid zone, efficient irrigation technologies like sprinkler and drip system should be popularized which aim at maximizing production per unit of irrigation water. Adoption of improved agronomic practices like use of improved varieties, timely weed control, use of fertilizers along with farm yard manure, in-situ rainwater harvesting, etc. can give good yields even in below normal rainfall years. Cultivation of water intensive crops should be discouraged.

Besides natural resources, livestock and permanent vegetation such as grasses and trees are strengths for survival of mankind in the arid regions. Management of grasslands with Lasiurus sindicus, Cenchrus ciliaris and Cenchrus setigerus and top feed species such as Prosopis cineraria, Acacia senegal and Tecomella undulata need priority attention. Such a silvi-pasture system survives annual droughts and provides rich fodder. Quality of fodder particularly the wheat straw given to cattle during drought is usually very poor. The fodder quality can be improved through urea/molasses treatment, thus improving animal health and productivity with very little investment. Management of common property resources such as grazing lands, dams, village ponds, etc. needs top priority by the people for themselves to combat drought in arid regions.

The drought situation like the present one during the past three year (1999, 2000, 2001) to occur in this region and it needs a proper planning to combat drought/famine. Drought impacts are generally more severe on livestock than on human beings. Some of the measures that can be taken up for combating drought could be as follows:

Short-term measures

1. Early warning and drought monitoring should be carried out on the basis of long, medium and short-term forecasts.
2. Constitution of task forces in each district to initiate relief measures immediately after the drought strikes.
3. Supply of good quality drinking water to human and livestock in severely affected areas.
4. Fodder banks should be established in the region. Low quality fodder/alternate fodder resources should be enriched to meet the protein demand.
5. Cattle camps should be opened and fodder should be provided at a subsidized rate.
6. Contingency crop plans should be prepared in advance to meet out the aberrant weather conditions such as early/late setting of monsoon and or early/late withdrawal of monsoon.
7. Implementation of crop and livestock insurance schemes.
8. Timely availability of credit, postponement of revenue collection and repayment of short-term agricultural loans.
9. Training of personal involved in drought relief measures on short/long-term basis.

Long-term measures

1. Greater coordination among like departments should be ensured.
2. Constitution of a drought monitoring committee to advise on drought situation.
3. Rainwater harvesting for both the drinking and in-situ cropping, improvement and popularization of traditional rainwater harvesting systems and rainwater conservation/efficient utilization.
4. Rejuvenation of traditional rainwater harvesting systems viz. Nadis, Tankas, Khadins, etc.
5. Systematic study on the use, artificial recharge and augmentation of groundwater aquifers.
6. Completion of IGNP lift canals to divert water to drought prone areas.
7. Human and livestock population should be managed to reduce the pressure on fragile arid ecosystem.
8. Popularizing the improved agronomic practices to maximize the crop yield per raindrop.
9. Integrated watershed management for efficient management of land and water resources should be given top priority. Appropriate land use planning, discouraging water intensive crops, encouraging sprinkler and drip irrigation systems, and practicing alternate land use such as agro-forestry, agro-horticulture and silvi-pasture would provide long-term drought proofing in the Indian arid zone.

ENVIRONMENTAL ISSUES AND SUSTAINABLE DEVELOPMENT IN DRYLANDS

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A prolonged, over-exploitative use and management, be it of the cultivated lands or the of grazing and forest lands, has set in motion a process of accelerated degradation. The problem is particularly serious in arid and semi-arid lands, which occupy 52 mha and 111 mha respectively and together constitute half of the geographical area of the country and support nearly one-third of the population. Through technologies have been in existence for long and some applications have also been made, the problem of land degradation continues and even aggravated in certain respects. Thus not only the precious natural resources continue to degrade but also the long-term livelihood security of a large population is in jeopardy. The present paper focuses on some topical situations and highlands critical research, development and policy issues that need to be addressed.

NORTH-WEST HOT ARID ZONE

Limit of sustainability of the desertic zone:

The region today has nearly 20 million of human population and 28.6 million of livestock. Every bit of land is not only being used but over used. There is widespread degradation of resources both of soil, vegetation and water as shown earlier. Even in a good rainfall year, the production of grains and fodder no longer lasts for more than a year. In fact the mean shortfall in fodder is estimated at 30 per cent or so. The droughts mean not only immense misery for the teeming millions but mounting of relief on a huge scale. The current years estimate on relief is around 1000 crore. A time has really come to make a rigorous scientific assessment of the number of human beings and livestock that the Thar can sustain taking all the good and bad years together and also the future productivity improvements that can be brought about through resource regeneration and big projects like the GNP. Such information would be a great help in guiding our strategies and policies for the future.

Policy issues in upkeep of common grazing lands:

The region has nearly five million hectare or 25 per cent of its geographic area as common grazing lands. Of this a small fraction is in form of small parcels in the dominantly agricultural region, called the gauchars and the agors and the rest major part as fairly large stretch in the less than 200 mm rainfall isohyet. Whereas, the former group belongs to the village panchayat, the later are mostly in form of culturable wastelands and designated pastures. These are open access lands. Because of persistent overgrazing, the vegetation cover and productivity of these lands has been brought to less than one-fourth of their potential. Technology has long existed for regeneration of these lands and the same had also been demonstrated. But even these developed lands once brought under community regime are degraded in no time. Every one is first to exploit these lands but no one to protect these. A major policy intervention is needed to ensure development and upkeep of lands through community organisation and technological backstopping.

Cultivation on dunes and other marginal lands:

Cultivation has spread greatly in the past few decades. The pre-existing crop lands are being used more frequently i.e. the useful practice of fallow farming has declined. Secondly, the marginally suited lands have been brought under plough. Even the dunes have not been spared. In the 400 to 250 mm rainfall zone, almost all dunes are being so used. But dunes are far more vulnerable to erosion and these are also a major source for spread of drift sands, which is menace already. Similarly, there are the lands in the 200-250 mm rainfall zone such as exist in the western part of the area. Not only the low rainfall, these lands lie in the more windy area. These lands have been brought under plough recently only, earlier these were under pastures. Land capability-wise these lands are much better suited to, silvi-pasture land use. This use is more conservative of the natural resource base and an improved animal husbandry may also be more rewarding economically. However, a critical assessment of the two systems is a clear necessity for land use planning.

Conservation of ground water:

The intensive monitoring net-work of the central and state groundwater departments brings out that majority of the aquifers are showing alarming decline in water table. These had long crossed the safe withdrawal limit. In fact current estimates are that these aquifers will dry out in the coming 25-50 years. All this is happening when we know that recharge is not only costly but the opportunity for it is highly restricted. Over much of the area, the waters are indeed historical, having accumulated during favourable climate interludes of the remote past. Thus what is being done is mining or irreversible exploitation for a large area. The minimum that can be done is to permit no further increase in quantum of extraction of water and to permit irrigation only with most efficient methods.

Improved management of IGNP command:

Indira Gandhi Canal Project is a gigantic project that aims to transform the economy Rajasthan and, of course, the desert. Of the total 1.68 mha to be irrigated, already 0.75 mha are commanded. Several cities and towns have their water supplies dependent on this system. Though in Stage I with well-suited, loamy soils great improvement in productivity have been realised, in Stage II the yields of crops are about half even with matching management. The soils here are sandy and not well suited to conventional irrigation. Besides low productivity, as much as 50 per cent of the applied water goes as unproductive deep drainage leading to water table build up. The technology of stage I is simply not working. The wind regime is also very strong. Thus a new technology based on wind beaks, pressure system of irrigation and use of slowly soluble fertilisers and so on is the immediate necessity. This is besides the problem of water table build up and secondary salinisation, which has affected already 30 thousand hectare or so and made another 0.2 mha vulnerable.

SEMI-ARID ZONE:

Unlike the arid zone water erosion, soil fertility deterioration and deforestation are the main environmental issues in semiarid areas. Of the total estimated 145 mha of water eroded areas, a major part lies in this zone. Water erosion takes away the productive top soil and sediments tanks and reservoirs. In large parts soil depth is already a limiting factor and erosion adds to this permanent disability. No less serious is the reduction in local water supplies caused by run-off. A variety of soils, namely the Vertisols, Inceptisols And Alfisols occur in this zone. The Vertisols are mostly left fallow in rainy season as the soils generally get too wet. Thus rabi crops are preferred but the success is dependent mainly on supplementary irrigation. In the other two soil regions, irrigation is not only a pre-requisite for double cropping but also for kharif crops in situations of early withdrawal of monsoons. Thus rainwater management holds key not only to soil conservation but also to viability of agriculture.

The above principal has long been realised in our country and watershed is the right hydrological unit to plan and implement soil conservation. Technologies also exist. But the success is limited to a few success stories here and there. What has emerged is that the watershed management is not merely technical solutions. People's participation, integrating the programme with other spheres of development, required investment and policy environment are the key requirements for scaling up of the programme.

Improving land productivity:

Because of uncertain productivity and response, the farmers in the region are averse to use of costly inputs and this is the reason that the yield of rainfed crops has almost stagnated. The situation will remain so unless cheaper alternatives are used. Biological nitrogen fixing and integrated pest management are the new science generated approached with immense promise. Strengthening of the existing mixed farming management and alternate land uses like agro-forestry, agro-horticulture are other avenues.

Re-greening of community lands:

Nearly half of the notified forest area is with little or no cover. Over the years considerable investment and physical effort has gone into afforestation. But the success stories are few, partly because of inadequate care and management but mainly due to the biotic pressure. Unless the programme is owned by the local communities, the programme has little chance of success. The same applies to common grazing lands and other CPR's. Policy and physical approach necessary for it needs to be developed and it seems as if NGO's can play a valuable role in the process of community organisation and delivery of services and goods. I am thankful to the ENVIS Centre for this opportunity to express my views on some current environmental improvement issues.

May these be peace in the clestial regions, may there be peace in the atmosphere, may peace reign on earth, may the water be soothing, may the medicinal herbs be healing, may the plants be the source of peace for all.

FOCUS ON GROUNDWATER RECHARGE

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INTRODUCTION

It is impossible to overstate the cruciality of need of water for man's civilised living, indeed his very existence. It is the most precious gift of nature and fortunately to us living in India's geographical boundary very plentiful. A combination of 6000 km long shoreline, 2500 km long unbroken chain of high mountains in the north and north-east, a very long and hot summer creates a giant precipitation-making machinery resulting in India's average annual precipitation of 543 mm, which is greater than global average of 314 mm. This sustains an annually replenishable utilisable surface water resources of 690 km^3 and groundwater resources of 420 km^3. In totality these resources can meet India's freshwater need, 1050 km^3, estimated up to 2025 AD. So, there is no cause for immediate worry for a quarter of a century, superficially.

But there is cause for worry, firstly due to space-time variation in rainfall and consequent runoff from west to far east (almost nil rainfall in Thar desert to 11 m in Meghalaya) and it's activity confined to only four (June to Septe4mber) watery months. Then, there are acute variations year after year, giving rise to drought and famine situations as also flood ravages. As a corrective measure a lot has been done in terms of creating storages (to obviate time variation) and canal construction (to obviate space variation) in preceding half a century since Independence. The interaction of surface flow and groundwater flow has prompted the planners to take a major initiative to plan on the basis of conjunctive use, i.e. surface and groundwater taken together, and not to treat them separately. This is possible only with improved recharge methods and pumping.

CONJUNCTIVE USE OF SURFACE AND GOUND WATERS

Bulk of surface and groundwater flows, about 75%, are used in irrigation, but still greater part of country depends on rain-fed agriculture. Failure of monsoon exposes the agriculture to drought and famine and other damaging effects, while above-average monsoon results in flooding, inundation and resulting devastation. Conjunctive use combines the advantage of groundwater storage and surface water systems and leads to efficient water management.

National Water Policy 1987 document directs that both surface and groundwater should be viewed as an integrated resource and should be developed conjunctively and in a coordinated manner. In times and places of higher rainfall or high availability of water on surface its transfer to groundwater can be induced by artificial recharge methods while during low rainfall period groundwater can augment surface supplies. Conjuctive use permits better flexibility in cropping pattern, helps in blending of brackish groundwater with fresh water in arid areas.

GROUNDWATER POSSIBILITIES IN INDIA

There are three type of formations in India that bear and yield groundwater. A large portion, about 36% area, consists of consolidated hared rock formation with little pore space but having joints, fractures and shear planes which can yield water by dug well or bore well upto as little as 1 lit. /sec. In semi-consololdated formation, about 1.5% area that includes Rajasthan, there is good porosity and tubewells and deep dug wells yield about 40 lit. /sec. At village Borunda about 105 km from Jodhpur dugwell encounters water at 50 m depth and yields nearly 500 lit/sec without showing any drawdown. In vast areas covering unconsolidated formations in Indus, Ganga, Brahmputra and coastal basins vast potential exists for dug, bore and tubewells to be added to vast number that already exists due to good porosity and availability of water to recharge and replenish the pumped or drawnout water. However, the overexploitation of groundwater should be avoided and artificial recharge should be encouraged there.

ARTIFICIAL RECHARGE OF GROUNDWATER

Recharge of groundwater (GW) is a component process of nature's hydrologic cycle in which precipitation incident on collected on groundsurface percolated through it to augment the groundwater storage. When this moment from surface to underground formation needs to be augmented beyond the natural process it is termed 'artificial recharge'. The latter are designed to serve one or more of the following purposes:

I. To maintain or augment natural GW as an economic resource

II. To combat adverse conditions such as progressive lowering of groundwater levels, unfavourable salt balance and (coastal) saline water intrusion

III. To store underground the surface waters imported from other basins

IV. To provide treatment and storage for reclaimed wastewater for possible reuse

Besides the obvious advantages of purposes listed in **i. ii.** And **iii**. Above, the last one has a particular relevance in today's urban civilisation and culture of recycling. Such installations have exponentially increased in highly urbanised in Western Europe and USA.

A variety of methods have been developed to artificially recharge the groundwater, choice of which is governed by local topographic, geologic and soil conditions, the quantity of water to be recharged, and ultimate water used intended. They are primarily based on water spreading, and classified as basin, streamchannel, ditch and furrow, flooding and irrigation methods, apart from use of recharge wells. Hydraulics of a recharge well is alike that of pumping well with direction of flow reversed, superficially speaking. However, recharge rates seldom equal pumping rates for other conditions being same, due to air and fine material carried by recharging water often partially clogging the pore spaces and reducing acquifer permeability. However, recharge wells are convenient for disposal of septic tank effluent, excess irrigation water. The recharge wells have been shown to be effective in combating GW salinity conditions, particularly in coastal regions.

RESEARCH FINDINGS AND LATEST DEVELOPMENTS

Research has continued on spreading methods, particularly basin and stream channel methods, to increase efficiency of (artificial) recharge. Continued recharge shows gradual decrease of recharge rates with time which is attributed to microbial growths clogging the soil pores. This has been confirmed by experimenting on sterile soils which show no decrease with time. This growth can be checked by addition of organic matter or chemical soil conditioners, or alternate wetting and drying of soil. Drying is believed to kill microbial growth and opens soil pores. Effect of other factors like sunlight, temperature and algal growths in water is under investigation.

Nuclear well logging techniques can be used to identify porosity of underground stratums. Methods using natural and artificial radioisotope tracers have been reported for pre-storage investigations to delineate the storage areas for purposes of artifical recharge. Nuclear techniques can be used to find if a GW body is getting replenished, if so the rate of recharge.

CONCLUSIONS

Groundwater is ideal means of storage of surface water which can obviate space-time unevenness with efficient artificial recharge methods and highly improved pumping techniques. Recharging wells are increasingly being used for liquid waste disposals for recycling and its subsequent reuse. This is a boon with prospect of water scarcity confronting us increasingly. In short, groundwater storage augmented by artificial recharge and served with efficient pumps is a solution to water conservation and water recycling which will be in increasing demand in water deficient twenty-first century.

DECLARATION OF THE GERMAN NETWORK ON RESEARCH TO COMBAT DESERTIFICATION

Combating desertification and mitigating the effects of drought is a rising challenge, the importance of which has not been sufficiently recognized in a context of global environmental change.

We, an interdisciplinary group of scientists in basic and applied research on desertification intend to:

- ♦ Identify pressing problems with regard to desertification;
- ♦ Development innovative research concepts which focus on applicability and interdisciplinarity;
- ♦ Raise public awareness to the alarming state of deserrtification;
- ♦ Strrengthen and support research capacities with the view to promolte scientific co-operation with affected countries;
- ♦ Establish and intensify linkages with international research partners;
- ♦ Establish a mechanism for policy advice.

For that purpose we form a network open to those scientists sharing our vision. We support the United Nations convention to Combat Desertification (CCD) and for this purpose we want to strengthen our co-operation with its scientific body, the committee on Science and Technology(CST).

On this basis, we want to structure and facilitate the communication of knowledge, and mobilize the necessary research for this purpose.

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