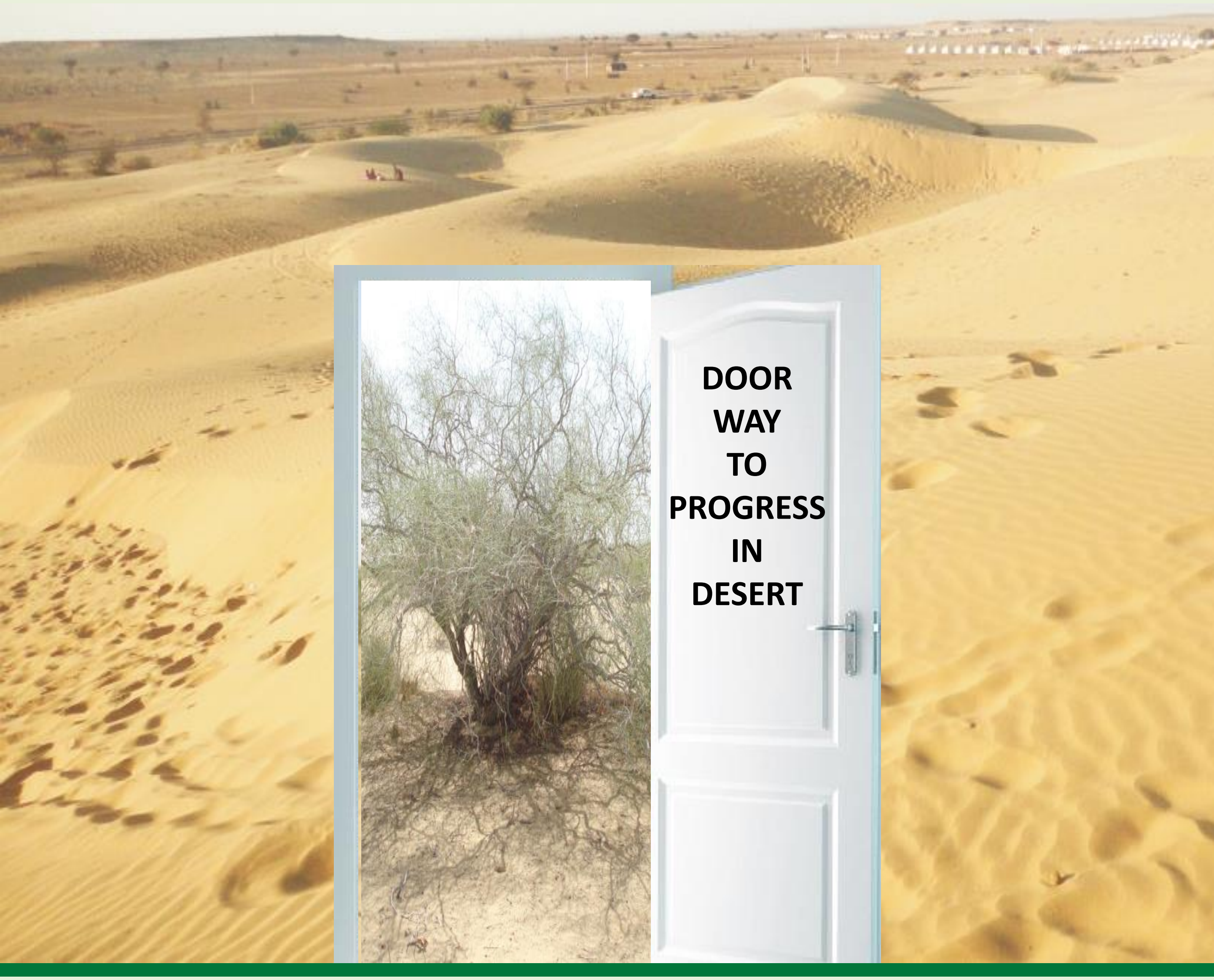
January - June 2021 Volume 23(1-2)

DESERT ENVIRONMENT NEWSLETTER

ENVIS Centre on Combating Desertification

ICAR-CAZRI

In this issue :



Hosted by
ICAR - Central Arid Zone Research Institute
Jodhpur

Supported by
Ministry of Environment, Forests and Climate Change
Government of India

Published by
ENVIS CENTRE
on Combating Desertification

From the desk of chairman

Dear Readers,

As a part of UNCCD's LDN and SDG 15.3 targets, India has stepped up its efforts towards setting the national targets of restoring 26 m ha land by 2030. The recent national database indicates ~ 96 m ha of land area representing ~ 30 per cent of country's total geographical area is under various process of degradation; erosion, salinity, alkalinity and anthropogenic activities. Rajasthan is the state with maximum area under arid environment (62% of country's total hot arid region) and Desertification (21.23 m ha or 62.06 % of TGA of the state). Interestingly, the state is witnessing reduced desertification in 2018-19, The degraded area has decreased by 3.87 lakh ha as compared to 2003-05. Radical transformation in the rainwater use and management, efficient use of ground water resources through micro-irrigation systems, availability of quality seeds/planting materials and agricultural implements, exploiting the use of renewable energy, adopting integrated farming systems for better economic returns and sustainable uses of natural resources are some of the approaches impacting visible change in arid land use/ land cover.

The present issue of DEN highlights some of the above issues through information on natural resources of Narmada Canal Command Area in Rajasthan and very useful information on the role of indigenous shrubs of the desert. Hope, the readers will find this information needful and interesting.

O.P. Yadav
Director, ICAR-CAZRI

Address for Correspondence
Dr. P.C. Moharana
ENVIS Coordinator
ICAR - Central Arid Zone Research Institute
Jodhpur 342003, INDIA

Phone
+91 291 2786931

Visit us at
http://www.cazrienvis.nic.in

Email at
cazri-env@nic.in

Editors: Dr. O.P. Yadav, Dr. P.C. Moharana
Dr. J.P. Singh and Dr. Vipin Choudhary

ENVIS TEAM
Dr. O.P. Yadav
Director ICAR-CAZRI & Chairman
Dr. P.C. Moharana
ENVIS Coordinator
Dr. J.P. Singh
Member
Dr. Vipin Choudhary
Member
Dr. Sangeeta Goyal
Programme Officer
Dr. Mayur Bhati
IT Officer / GIS Expert
Mr. Karmveer Singh Bhati
Data Entry Operator

Know Your Desert

Natural Resources Appraisal in Narmada Canal Command Area of Rajasthan, India

The Narmada Canal Project (NCP) area is located between 24°37´ to 25°18´ N and 71°3´ to 71°52´E covering a planned command area of 2.46 lakh ha in Jalore and Barmer districts of Rajasthan (Fig. 1). The Narmada canal and its network in the Thar desert of Rajasthan receives water from Narmada river, which originates from the Amarkantak in Shahdol district of Madhya Pradesh and run a great distance (≈1300 km) in Madhya Pradesh, Maharashtra and Gujarat states before entering into hot arid ecosystem. Length of main Narmada canal in Rajasthan is 74 km with 12 main distributaries/minors/lifts taking off water from main canal. The total length of distribution system comprising of distributaries, minors, sub-minors is about 1719 km. The NCP was designed to provide irrigation and drinking water to Jalore and Barmer district of Rajasthan.

For efficient utilization and optimized regulation of canal water, drip and sprinkler irrigation system have been made mandatory in the command area. The designed irrigation system of NCP consisted of three sub systems (i) drawing of water from canal into a surface water reservoir locally known as ‘diggies’ using gravity flow, (ii) distribution of water from ‘diggies’ to farmers’ field through underground high density polyethylene (HDPE) pipe networking solar PV pumping/electricity based system, and (iii) application of irrigation water in farmers’ field at each end node of the irrigation network using pressurized irrigation network e.g. drippers and sprinklers. Allocated share at each farmer’s field is decided by water user association committee for each ‘diggi’. Farmers in these two districts have started realizing the benefits of the canal water in crop production since its introduction in 2008. The intensive agricultural practices have now been followed by farmers due to availability of canal water in the region. Cropping system consisting of pearl millet (*Pennisetum glaucum*), mung bean (*Vigna radiata*) and clusterbean (*Cyamopsis tetragonoloba*) during kharif (rainy) season and wheat (*Triticum aestivum*), cumin (*Cuminum cyminum*), isabgol (*Plantago ovata*) and mustard (*Brassica* spp.) during rabi (winter) season is dominant in the canal command areas of NCP.

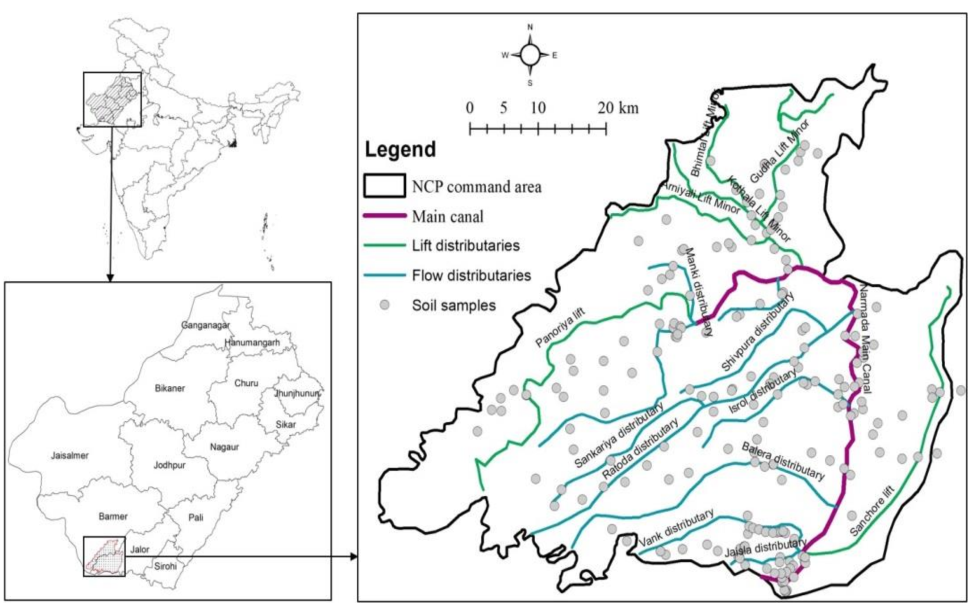


Fig. 1 Location map of Narmada canal ccommand area, Rajasthan

Geomorphic features and landform types in Narmada Canal command area

The Narmada command area in Jalore and Barmer district covers the lower reach of Luni river where it forms a deltaic plain along the Rann of Kutch. However there are several unique landforms. Based on interpretation of FCCs of IRS-LISS-4 satellite images, ten types of landforms have been identified (Fig. 2).

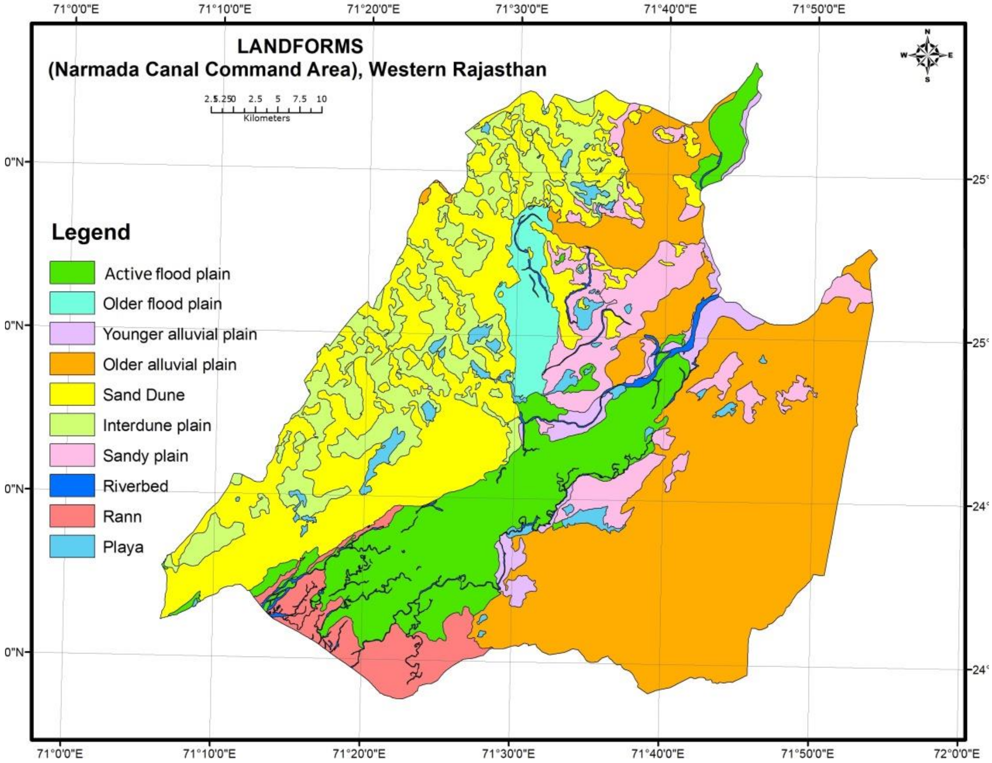


Fig. 2 Geomorphology map of Narmada canal command area

Alluvial plains (fluvial origin) occur in maximum area (~37 % of TGA of the command area) and have been further mapped as younger and older types. Younger alluvial plains occur on both sides of Luni river and form a part of flood plains. The older alluvial plains mainly in eastern part of command is a part of inter fluvial zone between the main riverbed of Luni river and its tributaries joining the Luni from the eastern flank. Flood plains occurring in 17.8 % area are located extensively on both sides of the Luni river and shows distinct fluvial morphology and drainage characteristics. It has been further subcategorised and delineated into active and older types. At the confluence of Luni river with Rann area, the width of active flood plain is maximum (about 19.4 km). The width however, reduces to 7-8 km near Isrol and Ranador village of Jalore in the middle reaches of river. The active flood plains exhibit several smaller, isolated and discontinuous narrow stream channels which are visible on FCCs of satellite images. The older flood plain forms the north-western part of younger flood plain and the land typically resembles a dry valley cutting through dune-interdune plains. Characteristically, this plain is similar to active flood plain having similar drainage characteristics such as occurrence of discontinuous and narrow stream segments and many of them are buried by sand. These plains are wider (2.8 – 5.3 km) near Chimra and Agdawa (Jalore) village and 2-3 km wide near Meethi village (Barmer). To the west of this older flood plain is the area under extensive sandy uplands which are part of Barmer district, comprising several of 12-30 m high parabolic sand dunes and interdune plains occurring in 32 % area.

Dune areas are mostly witnessed near Daboi, Meethi, Kaboli, Chalknechyaji, Gangapur and Bakhasar villages (Barmer). Such dunes nearer to Rann areas in the south are of transverse types. About 7% area is under scattered occurrence of sandy plains. Within the sandy undulating terrain, there are several inland saline depressions or playas which are remarkable features in the entire region. On the basis of their extent, they have been further categorised into smaller (0.2 to 0.6 km^2) and bigger types (3 to 9 km^2). Larger playas are located near Veriya and Doongri (Jalore) (in 9 km^2 area), Megawa (in 6 km^2 area) and south of Bherudi (Barmer) (in 3.5 km^2 area) are elongated and roughly round in shape. Between Bakhasar in the south and Pandawali (Barmer) in the north, saline depressions developed within the narrow interdune plains are linear shaped with a west to east alignment. One such saline depression at Veriya village (Jalore) is shallow and elongated (about 8 km long and 1.5 km wide) with a north-south alignment. The basin area has been categorised into four elevation zones; 64-136 m (in sand dune areas) covering north-western part of the basin, 43-64 m (in sandy plains and sandy older alluvial plains), 26-43 m (in flood plains, older alluvial plains and interdune plains) and -37 to 26 m in rann and saline depression or playa areas.

Soil Resources Characterization

Soil resources survey and characterization has been carried out on 1:50,000 scale following three tier approach i.e. image interpretation (IRS LISS III data); field investigation, and laboratory characterization (Soil Survey Staff 2003); and cartography. Five soil series and their phases were characterized and mapped (Table 1) in the course of investigation. Three soil series Sanchore, Dhorimana, Chohtan and Dune complex belonged to the aeolian plains covering 74 % area of NCP and Chitalwana soil series was identified (Fig.3) in alluvial plains (16 % area of NCP).

Soils of the Narmada canal command area are yellowish brown (10 YR 5/4) to brown yellowish brown (10 YR 4/4). An excessive drainage attributed to dark brown colour in sub soils of Sanchore series. Hummocky phase of Sanchore and Dune complex series showed similar colour characteristics (10 YR 6/4 to 10 YR 5/4) at the surface because of common source of aeolian sand. Soft powdery lime in Sanchore and Dhorimana series was found to increase with depth and internal drainage was observed excessive to well, depending upon topography and clays. Fine sand and loamy sand texture was dominantly observed on the surface and in the subsurface, respectively in Sanchore and Dhorimana series. Fine sand characterized dune complexes, while loamy sand textural classes were noted below the surface in Sanchore Dhorimana and Chohtan series (Fig.3). Soils of Chitalwana series showed dominantly silty clay loam textural class at the surface and sandy loam, sometimes loamy sand in the sub surface. Structurally soils were single grained on the surface and had very fine to fine, weak sub-angular blocky structure in the subsurface of Sanchore and Dhorimana series. Structure development ran parallel to the clay content and textural class. Mark of stratification and sign of sedimentation were the characteristic features of Chitalwana series.

A-C horizon sequence is characterized in all the identified above four soil series. Based on these characteristics, Sanchore, Dhorimana, Chohtan and Dune complex series are classified as Psamments, while Chitalwana soils are classified into Fluvents sub orders. Accounting aridic soil moisture regime as the differentia characteristics at great group level, Psamments and Fluvents were further classified as Torripsamments and Torrifluvents, respectively. Torripsamments and Torrifluvents represented the central concept of great group, consequently classified as TypicTorripsamments and TypicTorrifluvents at sub group.

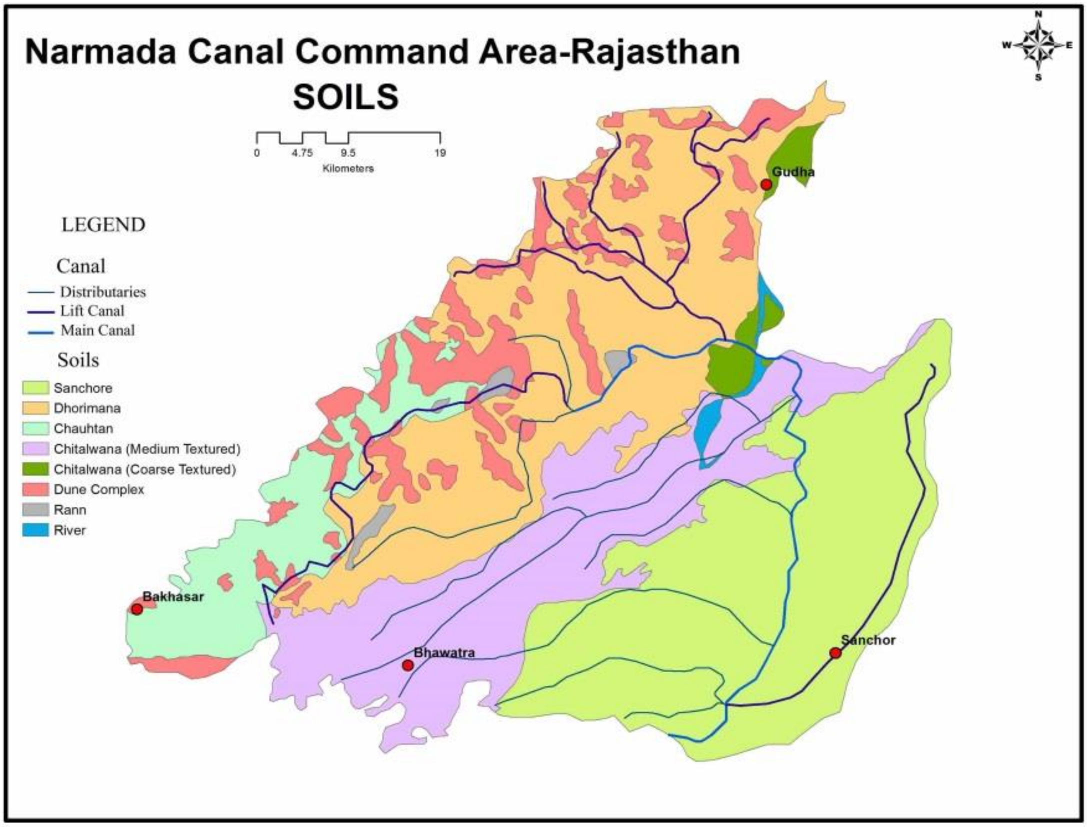


Fig. 3 Soils of Narmada canal command area, Rajasthan

Soil Resources Characterization

Soils of NCP are generally alkaline in reaction with pH value ranging from 7.62 - 9.98. Soil EC varied from 0.02 to 14.30 dS m^{-1} and most of the soil samples were found in normal range (<1.0 dS m^{-1}). The highest EC of 14.3 dSm^{-1} was recorded in alluvial soils in deltaic region of Luni river ephemeral stream carrying brackish water. Average OC content of soils have been observed as 0.14% with a range of 0.03–0.42%. Organic carbon (OC) content of soils were observed highest under irrigated crop lands and lowest in rainfed croplands. Higher amount of OC in irrigated croplands might be due to addition of crop residues in the soil, high soil temperature, and vegetative cover these land use categories.

Available P content in soils showed wide variability with a range 1.41 and 47.84 kg ha^{-1}. The situation is much better in the canal irrigated croplands, where the high values are obtained especially in the alluvial soils in command areas of Shivpura, Sankariya and Ratoda distributaries. Higher content of available P in irrigated croplands might be due to continuous addition of phosphatic fertilizers and organic manures because of intensive cultivation during both rabi and kharif seasons and partly may be due to the inheritance from parent materials. Available K content varied from 56.25 to 652.50 kg $ha^{-1}$with an average of 178.26 kg ha^{-1}. Contrary to the situation of P, the mean status of K is the lowest in the irrigated croplands(average 153.9 kg ha^{-1}), followed by rainfed croplands (average 244.68 kg ha^{-1}). Lower content of soil potassium in irrigated lands than rainfed croplands might be due to continuous cropping without replenishment of depleted potassium reserve in soil. Soils were found deficient in available Fe and Zn and adequate in available Mn and Cu in the command area across the land uses. The DTPA-extractable zinc (Zn) in the soils of Narmada canal command area of Rajasthan varied from 0.08 to 2.40 mg kg^{-1}, with a mean of 0.38 mg kg^{-1}, which is low. Overall, Zn deficiency was found over large parts of the command area, therefore, there is a need for Zn fertilization at recommended doses for rational crop yields. The DTPA-extractable copper (Cu) in the soils varied from 0.02 to 1.38 mg kg^{-1}, with a mean value of 0.34 mg kg^{-1}, which suggests adequacy. The DTPA-extractable iron (Fe) ranged from 0.85to 13.46 mg kg^{-1}, with a mean of 3.47 mg kg^{-1} and could be considered as low. Canal irrigated croplands areas were better endowed in Fe content in comparison to the, rainfed croplands (Table 1). Despite the localized natural endowment, Fe deficiency was found in most part of the command area, which needs further attention. The DTPA-extractable manganese (Mn) in the soils ranged from 1.72 to 14.55 mg kg^{-1}, with a mean of 5.26 mg kg^{-1} i.e., moderately high. Overall, the command area was well supplied with Mn contents (Table 1).

Table 1 Soil physicochemical and chemical properties in canal command area of Narmada Canal Project (NCP) in Rajasthan, India

Soil properties	Range	Mean	Standard deviation
Sand (%)	34.90-93.00	82.20	16.45
Silt (%)	2.50-26.50	7.14	7.04
Clay (%)	4.50-38.50	10.55	9.43
Bulk density (Mg m^{-3})	1.30-1.61	1.54	0.07
Water holding capacity (%)	17.50-39.80	23.08	5.53
CEC (c mol (p+) kg^{-1})	2.50-40.00	6.35	9.58
$CaCO_3$ (%)	0.02-12.50	3.05	3.02
pH	7.62-9.98	8.70	0.39
EC (dS m^{-1})	0.02-14.30	0.541	1.68
Organic Carbon (%)	0.03-0.42	0.14	0.07
Available N (kg ha^{-1})	61.91-191.00	102.25	27.23
Available P (kg ha^{-1})	1.41-47.84	10.38	8.62
Available K (kg ha^{-1})	56.25-652.50	178.26	107.91
DTPA extractable Fe (mg kg^{-1})	0.85-13.46	3.47	2.20
DTPA extractable Mn (mg kg^{-1})	1.72-14.55	5.26	2.44
DTPA extractable Zn (mg kg^{-1})	0.08-2.40	0.38	0.30
DTPA extractable Cu (mg kg^{-1})	0.02-1.38	0.34	0.25

Land use land cover in NCP

Based on interpretation satellite images (IRS-LISS III of rabi period, 2017) and using supervised classification, six types of land use / land cover has been identified and mapped using GIS for the Narmada canal command area (Fig.4). Agricultural lands covered the maximum area (~71 % area) because of canal system and stream channels. Forests and plantation area occur in about 1772 ha area. The western part (within Barmer district) is mostly dune covered in about 18 % area. The part of riverbed of Luni in 6140 ha (1.81 %) area, saline wastes (playas) in 3.4 % area and waterlogged/wetlands areas in 4.50 % area are the other distinct land cover types.

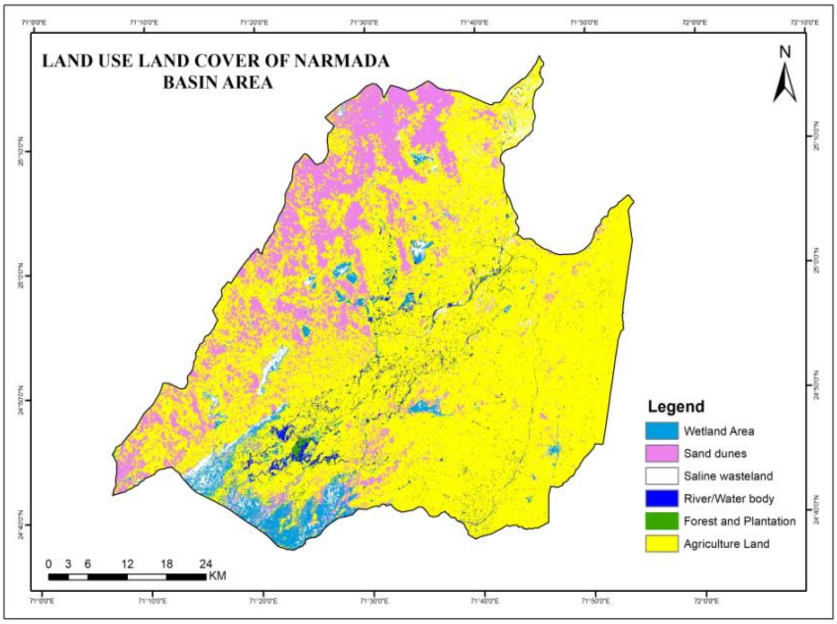


Fig. 4 Land use land cover map of Narmada canal command area, Rajasthan

Surface and Groundwater Resources in NCP

The groundwater potential zone 13.89% (46798.9 ha) comes under younger alluvium with yield of 80-250 m^3 day^{-1} whereas 53.67% (180761.6 ha) is under older alluvium with yield of 60-200 $m^3 day^{-1}$ in the entire NCP. The remaining area (32.43%) lies in non potential zone. Depth of groundwater in the deltaic region of Luni river was about 5-7 m below ground. The area under groundwater depth of 10-20 mbgl has been increased from 77260 ha to 146368 ha whereas earlier area under 5 to 10 m depth was 132903 ha which has reduced to 44682 ha indicating wide spread withdrawl of water for irrigated agriculture. The advent of Narmada canal in some areas has led to recharge of groundwater mainly due to seepage. Earlier the area under >40 mbgl depth was 8866 ha which was reduced to 936 ha indicating deep recharge of groundwater mainly due to canal. 23% area (77797 ha) of NCP in Barmer district is reporting a rise of groundwater table by 0-3 m. However in 13.56% area (45701 ha) of Barmer district slight depletion of groundwater by 0 to -1 m was also observed. 14% area of NCP in Jalore district reported decline of groundwater table by 0 to -3 m whereas 1% also recorded deep decline of groundwater by -3 to -7 m.

The groundwater samples were collected along the distributaries/minors and results of their analysis show that electrical conductivity (EC) of groundwater increased from head to lower reaches along all the distributaries, sub distributaries and minors. EC of groundwater ranged from 0.23 to 9.20 dS m^{-1} with an average of 3.95 dS m^{-1}. pH of groundwater varied from 7.80 to 9.10. Among the cations present in groundwater, Na+ was the dominant followed by Mg+ and Ca^+. In case of anions, they were present in the decreasing order of Cl^{-1}>HCO_3^{-1}> CO_3^{-2}. Most of the groundwater samples are under high chloride class. Residual sodium carbonate was not present in the water except at Siwara in Jalore (5.96 meq/l).The deteriorating groundwater quality further adds misery to the downstream farmers by degrading productivity of their lands caused by excessive use of saline groundwater. However, presence of large number of diggies in canal command area has greatly helped in manging the water supplied by canal.

Mahesh Kumar, P. Santra, P. C. Moharana, R. K. Goyal, N. R. Panwar and C. B. Pandey
ICAR - Central Arid Zone Research Institute, Jodhpur

Protective Role of Indigenous Shrubs in Hot Arid Region

Vegetation cover has been recognized to protect soil from water and wind erosion from time immemorial. In addition to soil protection, plants aid in the binding of particles to the fibrous root system. Plant density and plant morphology are the two most important factors that influence sand arresting. Most of the shrubs, under-shrubs and grass species of Indian arid zone are very good sand binders. In arid regions, shrubs play a resilient role in arresting soil erosion and combating desertification because of their ability to tolerate biotic pressure, conserve soil, and promotion of biodiversity.They are good at halting soil movement because of their low and compact canopy, which covers the soil all year. Seasonal and environmental fluctuations have also little effect on shrub stands, which make them important in harsh climatic situations. The multi branch character of shrubs like *Acacia jacquemontii* (Bawli), *Calligonum polygonoides* (Phog), *Crotalaria burhia* (Sinia), *Haloxylon salicornicum* (Lana), *Leptadenia pyrotechnica* (Kheep), *Ziziphus nummularia* (Bordi) etc. not only prevents soil erosion but arrest the eroded soil particles particularly fine sand, silt and clay which are enriched in essential plant nutrients. Soil physical properties are usually recognized as important soil quality indicators. In arid and semi arid ecosystems, where variation in spatial and temporal availability of water and nutrients is at extreme, dominant woody plants cause changes in micro-climate and soil properties that lead to complex local interactions between vegetation and soil. They improve the surface soil texture, enhance water holding capacities, increase the levels of soil organic carbon, available nutrients and reduce soil pH which in turn helps in increasing the uptake of nutrients. The levels of nutrient enrichment underneath shrubs may vary among species due to differences in vegetative cover, N mineralization, and nutrient absorption.

The evaluation of diverse germplasm of *C. polygonoides* and *H. salicornicum* at ICAR-CAZRI, RRS, Bikaner showed that in initial planting stage accessions of *H. salicornicum* showed highest sand deposition followed by *C. polygonoides*. Some of the shrub species such as *L. pyrotechnica*, *Z. nummularia*, and *C. burhia* are commonly used to create micro wind barriers in sand dune stabilization. Traditionally, many of the indigenous shrub species are used as live fence, which also act as wind break for crops. Shrubs like *C. polygonoides*, *H. salicornicum*, *Z. nummularia* etc. also improve the habitat for other plant species that grow beneath their protection by improving the biological and microclimatic conditions.The natural stands of *H. salicornicum* is also provide congenial conditions for growth of wild edible mushrooms. The purpose of this article is to highlight important native shrubs of the hot dry region that have a protective role in combating desertification.

Acacia jacquemontii Benth. (Bawli, Bu-banvali)

It is one of the important leguminous native shrubs naturally found on sand dunes, sandy undulating plains and river bed terrace. It forms very gregarious formation on sand dunes and sandy plains through its multiple branches. It works as a good sand binder on the bare sand dunes. Its extensive root system makes it ideal for dune stabilization and preventing soil erosion. The desert inhabitants give much emphasis on promoting A. jacquemontii on sand dunes as source of browse, edible gum and also used as a live hedge on bunds of agricultural fields.

Aerva javanica (Burm.f.) Schult. syn. *A. tomentosa* Forsk. (Bui)

This woody under shrub with large panicles of spikes is usually found in sandy habitats and very often seen in newly deposited loose sand. It has a deep root system and may be employed in desert reclamation as a soil binder. Because of its drought resilience and low water requirement, this plant is also suited for sustainable landscaping in desert climates.

Calligonum polygonoides L. (Phog)

In western Rajasthan, this tall, leafless shrub is usually found on sand dunes either alone or in association with other plant species like *Lasiurus sindicus* (Sewan ghas), *Cenchrus ciliaris* (Anjan ghas), *Panicum turgidum* (Murath ghas), *Aerva javanica*, *Leptadenia pyrotechnica*, etc.. It is a slow growing, highly branched, 1–3 m in height under natural conditions with well developed root system adapted to arid climate. The roots and branching stem are used as fuelwood because of its high

calorific value. It is a pioneer woody perennial that colonizes newly deposited sands and provides green cover to the desert under adverse climatic conditions. It thrives on sandy hummocks and dunes, particularly on crests with fresh sand deposits. It is one of the potential plant species for immobilizing shifting sands in sandy environments. Because of its shrubby structure and extensively spreading roots, it is an ideal species for soil binding, reducing soil erosion and stabilizing sand dunes. Studies indicate that the species is having about two to three times more below ground biomass compared to that above ground biomass. Aside from providing protection, the live hedge of *C. polygonoides* also helps to minimize erosion, runoff, and precipitation infiltration. Traditionally, the branches of *C. polygonoides* are spread as mulch during summer and supposed to increase the soil fertility in crop fields.The species plays a crucial role in carbon sequestration through its below ground biomass.

Calotropis procera (Ait.) R.Br. (Aak)

This shrub is commonly found in wastelands and abundant in desertic zones. It grows gregariously and extensively on sandy plains, sandy undulating plains, and also in interdunal hummocky plains and sand dunes. It is most common drought resistant shrub of western plains of Rajasthan. It tolerates rigorous cutting and attains full height in a year’s. Its leaves are used as organic amendments.

Capparis decidua (Forssk.) Edgew. (Kair)

This leafless spiny shrub or small tree is commonly found on rocky as well as in consolidated sandy places throughout the arid region. Its principal roots, which grow directly downwards, tend to go deep, whereas the lateral branches spread out over a wide area. *C. decidua* is fast colonizer of the newly developed sandy hummocks, and multiply to spread themselves as the hummocks grow in size. It helps in controlling wind erosion in sandy areas and can be very well utilized for shelterbelts to check the movement of sand. It is also one of the most significant species for animals to use as a protective shelter from the blowing heat in the summer for resting purpose.

Crotalaria burhia Buch.-Ham. (Sinia)

This multi-branched drought-tolerant deciduous under-shrub is prevalent in desertic zones' sandy environments. Its well-developed colonies can be found on sand dunes, sandy alluvial plains, and sandy undulating plains. In sand dune stabilization programme, the entire plant of *C. burhia*, as well as thorny branches of *Z. nummularia*, twigs of *C. procera*, and *L. pyrotechnica*, are utilized to create micro-wind breaks by planting in parallel rows or in a

This multi-branched drought-tolerant deciduous under-shrub is prevalent in desertic zones' sandy environments. Its well-developed colonies can be found on sand dunes, sandy alluvial plains, and sandy undulating plains. In sand dune stabilization programme, the entire plant of *C. burhia*, as well as thorny branches of *Z. nummularia*, twigs of *C. procera*, and *L. pyrotechnica*, are utilized to create micro-wind breaks by planting in parallel rows or in a checkerboard pattern. Its compact pattern of growth helps the plants endure strong desert winds and accumulate sand particles to prevent uprooting. It has an important role in initial colonization of the bare dunes. *C. burhia* is also traditionally used as mulch material to create micro wind breaks in Birani Badi (A technique of growing vegetables with minimum water in Bikaner district.

Haloxylon salicornicum (Moq.) Bunge ex Boiss. (Lana)

This succulent dwarf shrub thrives on sandy undulating hummocky plains, dunes, and interdunal areas with limited rainfall. Its extensive and deep tap root system makes it drought and frost resistant, as well as allowing it to grow strongly throughout the hot summer months.

H. salicornicum is a great sand binder and a crucial shrub for hyper dry conditions with less than 100 mm of yearly precipitation. In a study conducted at the ICAR-Central Arid Zone Research Institute's (CAZRI, Jodhpur) Regional Research Station in Bikaner, it was found that distinct *H. salicornicum* accessions could deposit 7.5 to 15.8 cm soil depth in three years. The amount of soil arrested by these accessions ranged from 42.3 – 260.7 kg plant $^{-1}$.

Haloxylon stocksii (Boiss.) Hook.f. syn. *Haloxylon recurvum* (Moq.)Bunge ex Boiss. (Khara lana, Saji lana)

This straggling shrub is one of the important halophytic species of Thar Desert. Since long, it is being traditionally used for making Saji (a product of bicarbonate used in Papad industry). It is drought and frost hardy species. The species, apart from its economic importance in Papad industry, is also a good soil binder.

Leptadenia pyrotechnica (Forsk.) Decne (Kheep, Khimp)

This branching shrub is commonly found on arid sandy soils throughout the desert. It grows well on sand dunes, sandy river plains, interdunes, sandy hummocks and sandy undulating plains. It is one of the drought hardy species of sandy habitats with good moisture in lower profile. *L. pyrotechnica* is a strong soil binder, making potential species in sand dune fixation. It can play an important role in the desert afforestation programs as it is a good colonizer of sandy plains and dune areas. The dominant patches of *L. pyrotechnica* accumulate sand particles resulting the formation of sand mounds. In such places the dunes and interdunal plains are usually barren except *L. pyrotechnica* along with *Aerva javanica*. It has an important role in initial colonization of the bare dunes when its material is used as local raw material in the checkerboard or parallel hedges as micro wind breaks to halt the movement of sand prior to planting work in sand dune stabilization programme. The intact ripe fruits with its branches germinate in favorable condition, provide good protection against wind erosion and establish well in adverse conditions.

Lycium barbarum L. (Morali)

This spinous shrub is common in scrub forests, particularly in desertic zones. It is browsed by goats and camels. Traditionally, its twigs are used in crystallization of salt in the local salt industry. It can be planted as hedge or windbreak in arid areas. This species needs research attention to exploit its potential as multiuse species.

Ziziphus nummularia (Burm.f.) Wight & Arn. (Jhar-bor, Bordi)

This thorny shrub with many branches can be found in wastelands, especially in desertic zones, and is an important part of the Thar desert's woody vegetation. It is drought resistant and an excellent sand binder because of its horizontal, lateral, and secondary roots that run the length of the root. Wind erosion is reduced by *Z. nummularia*, which aids soil deposition in and around them and changes the microenvironment.

Shrubs by virtue of their morphological and physiological adaptation play a vital role in the hot arid ecosystem. Some of the most important protective shrubs of hot arid region such as *Acacia jacquemontii, Calligonum polygonoides, Capparis decidua, Haloxylon salicornicum, Leptadenia pyrotechnica* etc. have evolved to thrive in harsh climatic conditions. Because of their spreading crown cover near the ground and their extensive root system that spreads in all directions, help keep soil particles intact and reduce wind erosion. Planting of these species is feasible on marginal lands that are unsuitable for crop cultivation and can offer long-term yields from the arid rangelands. These species are also important contributors to the preservation of rich diversity in arid habitats that are threatened by desertification and salinization. Therefore, there is need to create the awareness amongst the desert inhabitants for conservation and promotion of key protective species in the region

J.P. Singh, M.L. Soni and V.S. Rathore

ICAR - Central Arid Zone Research Institute, Jodhpur

Knowledge Corner

Temporal Variation of Excess, Normal and Deficit Rainfall at Jodhpur

Arid Rajasthan is characterized by low rainfall and its erratic distribution both in space and time, high atmospheric temperature that has large diurnal and seasonal variations, high solar radiation and persisting wind regime. Consequently, crop water requirements as well as irrigation demands are high in the region. The weather conditions remain too dry, even in normal years, for most part of the year and are inhospitable for successful crop growth. The average values of the long-term annual mean, maximum and minimum temperatures for Jodhpur are 27.1, 38.3 and 20.4°C, respectively. The long-term mean annual rainfall in the area is 397 mm; the south-west monsoon (June-September) contributes 350 mm (88% of the mean annual rainfall with coefficient of variation of 47%). Normal onset of the south-west monsoon is about 10th July and withdrawal is about 19th September so that the duration of monsoon is about 71 days.

Sen's slope estimation test indicated positive trends in the annual and monsoon season rainfall over a period of 54-year (1967-2020) with magnitudes of 0.47 and 1.37 mm year^{-1}, respectively whereas negative trends were detected in the winter and post-monsoon season rainfall. However, none of the trends were revealed to be statistically significant at 0.05 level of significance according to the results of Mann-Kendall trend test (Table 2). In monthly rainfall, results of the Sen's slope test revealed that rainfall is increasing at a rate of 0.32, 0.60, 0.35 and 0.06 mm year^{-1} in June, July, August and September, respectively. In addition, results of the Mann-Kendall test indicated that rainfall is increasing in all months except February and November when the rainfall showed decreasing trends. Similar to seasonal rainfall, monthly rainfall trends were not found significant in the area. Recently, it is observed that the rainfall patterns in the Indian arid regions are substantially changing after the year 2000 with occurrence of high-intensity rainy storms over a short-duration. Hence, the annual rainfall of Jodhpur for a period of 54-year (1967-2020) was divided into two subseries: (i) 30-year (1967-1996), and 24-years (ii) 1997-2020.

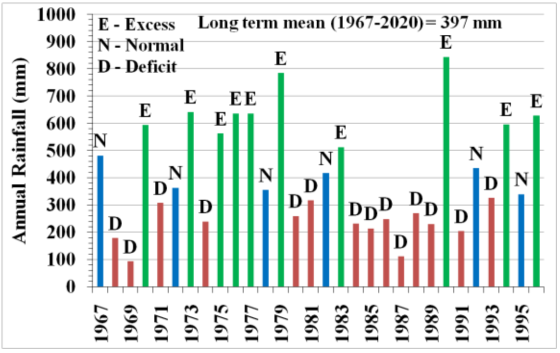
The annual rainfall of every year into both the subseries was classified into three categories of excess, normal and deficit following the criterion suggested by the India Meteorological Department (IMD), Pune, and the same is shown in Fig. 5(a, b). It is seen from Fig. 5(a) that the annual rainfall could be classified into excess, normal and deficit in 5, 2 and 3 years, respectively during the 1971-1980 decade, which is considerably different from number of excess (2 years), normal (1 year) and deficit (7 years) observed in the very next decade (1981-1990). An important observation of these two decades is consecutive 3-year excess rainfall during 1971-1980 and consecutive 6-year deficit rainfall during 1981-1990 in the area. On the other hand, the annual rainfall during 2001-2010 decade showed excess, normal and deficit in 1, 3 and 6 years, respectively, which is considerably different from excess (4 years), normal (4 years) and deficit (2 years) rainfall occurred during 2011-2020 decade (Fig. 5b). Also, there was a deficit rainfall in four consecutive years in 2001-2010 decade, whereas, normal rainfall in four consecutive years and two times excess in consecutive 2 years during 2011-2020 decade. It is further observed that there exists a prominence of excess and deficit of annual rainfall in alternative decades. It is also revealed that the magnitude of annual rainfall in case of excess events is less during the latest 24-year period (1997-2020) in comparison to that in the previous 30-year period (1967-1996).

It is apparent that the amount of annual rainfall in case of excess events was largely more than 600 mm in previous period (1967-1996), which in the latest period (1997-2020) was observed near to or less than 600 mm. From the above findings, it is very much clear that the annual rainfall patterns have been considerably changing in this arid region mainly due to increasing frequency of daily extreme rainfall events although the average amount of annual rainfall is found less than that observed in the previous 30-year period. It is worth-mentioning that the annual rainfall has been either in normal or excess state over nine of last 10 years (2011-2020) compared to its long-term 54-year mean. This finding indicates that the rainfall has been increasing in this traditionally water-short region, which emphasizes need of suitable practices of rainwater harvesting and conservation for managing surplus rainwater quantities.

Table 2 Rainfall trends identified by Mann-Kendall trend test during 1967-2020 at Jodhpur

Month/Seasonal/Annual	z-value	p-value	Sen's Slope (mm yr^{-1})
January	0.62	0.534	0
February	-1.29	0.196	0
March	1.10	0.273	0
April	1.73	0.084	0
May	0.17	0.862	0
June	1.28	0.199	0.3
July	0.78	0.433	0.6
August	0.57	0.566	0.4
September	0.28	0.777	0.1
October	0.21	0.837	0
November	-0.50	0.618	0
December	1.42	0.156	0
Winter	-0.54	0.588	0
Summer	0.07	0.946	0
Monsoon	0.98	0.325	1.4
Post-monsoon	-0.52	0.605	0
Annual	0.68	1.139	0.5

Note: z-value is value of Mann-Kendall test-statistic.



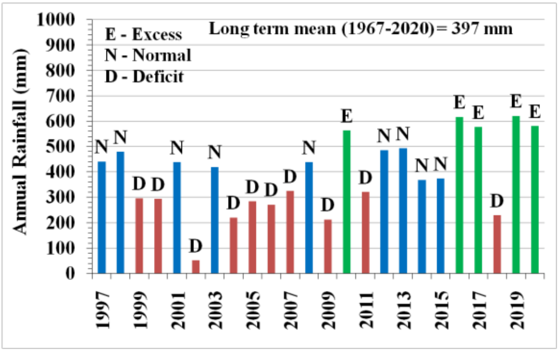


Fig. 5(a,b) Bar charts of annual rainfall showing excess (E), normal (N) and deficit (D) rainfall during (a) 30 years (1967-1996) and (b) 24 years (1997-2020)

H.M. Meena, D.V. Singh and D. Machiwal
ICAR - Central Arid Zone Research Institute, Jodhpur

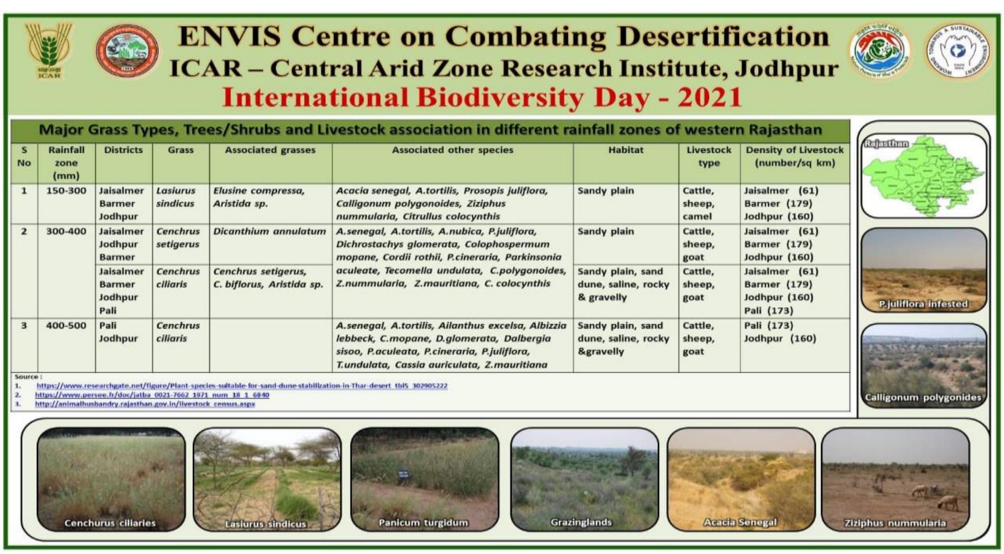
ENVIS Activities

National Science Day

Celebrated National Science Day on February 28, 2021 on the theme "*Future of STI: Impact on Education Skills and Work*". Dr. P.C. Moharana, P.S. & Coordinator ENVIS, CAZRI highlighted the importance of the National Science Day and role of the ENVIS centre. Prof. Rajesh Kumar, Head, Department of Environmental Science, Dean, School of Earth Sciences, Central University of Rajasthan, Ajmer was the Guest Speaker and talked on "*Climate Change and its Impact on Glaciers: The Role of Science and Technology*". He briefed on various aspects of origin, formation and rate of movement of the Glaciers and also informed that by 2050 the severity of widespread summer drought is projected to nearly triple. The webinar was attended by scientists, technical officers and other officials.

International Biodiversity Day

Celebrated International Day of Biodiversity on May 22, 2021 by releasing a poster on major grasses of western Rajasthan. The poster illustrated the major grasses, trees\shrubs and livestock association in different rainfall zones of western Rajasthan. It also stated district wise distributional pattern of livestock species.


ENVIS Centre on Combating Desertification
ICAR – Central Arid Zone Research Institute, Jodhpur
International Biodiversity Day - 2021

Major Grass Types, Trees/Shrubs and Livestock association in different rainfall zones of western Rajasthan

S No	Rainfall zone (mm)	Districts	Grass	Associated grasses	Associated other species	Habitat	Livestock type	Density of Livestock (number/sq km)
1	150-300	Jaisalmer Barmer Jodhpur	*Lasiurus sindicus*	*Elusine compressa, Aristida sp.*	*Acacia senegal, A.tortilis, Prosopis juliflora, Calligonum polygonoides, Ziziphus nummularia, Citrullus colocynthis*	Sandy plain	Cattle, sheep, camel	Jaisalmer (61) Barmer (179) Jodhpur (160)
2	300-400	Jaisalmer Jodhpur Barmer	*Cenchrus setigerus*	*Dicanthium annulatum*	*A.senegal, A.tortilis, A.nubica, P.juliflora, Dichrostachys glomerata, Colophospermum mopane, Cordii rothii, P.cineraria, Parkinsonia aculeate, Tecomella undulata, C.polygonoides, Z.nummularia, Z.mauritiana, C. colocynthis*	Sandy plain	Cattle, sheep, goat	Jaisalmer (61) Barmer (179) Jodhpur (160)
		Jaisalmer Barmer Jodhpur Pali	*Cenchrus ciliaris*	*Cenchrus setigerus, C. biflorus, Aristida sp.*		Sandy plain, sand dune, saline, rocky & gravelly	Cattle, sheep, goat	Jaisalmer (61) Barmer (179) Jodhpur (160) Pali (173)
3	400-500	Pali Jodhpur	*Cenchrus ciliaris*		*A.senegal, A.tortilis, Ailanthus excelsa, Albizzia lebbeck, C.mopane, D.glomerata, Dalbergia sisoo, P.aculeata, P.cineraria, P.juliflora, T.undulata, Cassia auriculata, Z.mauritiana*	Sandy plain, sand dune, saline, rocky &gravelly	Cattle, sheep, goat	Pali (173) Jodhpur (160)

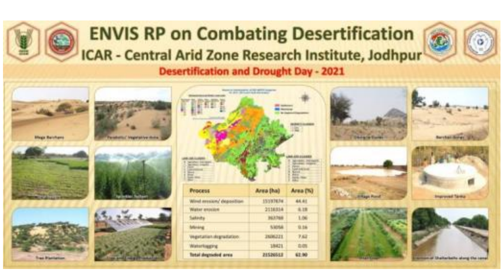
Source :
1. https://www.researchgate.net/figure/Plant-species-suitable-for-sand-dune-stabilization-in-Thar-desert_tbl5_302905222
2. https://www.persee.fr/doc/jatba_0021-7662_1971_num_18_1_6840
3. http://animalhusbandry.rajasthan.gov.in/livestock_census.aspx

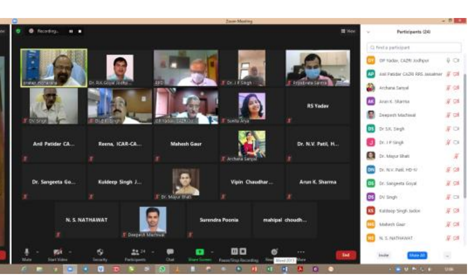
World Environment Day

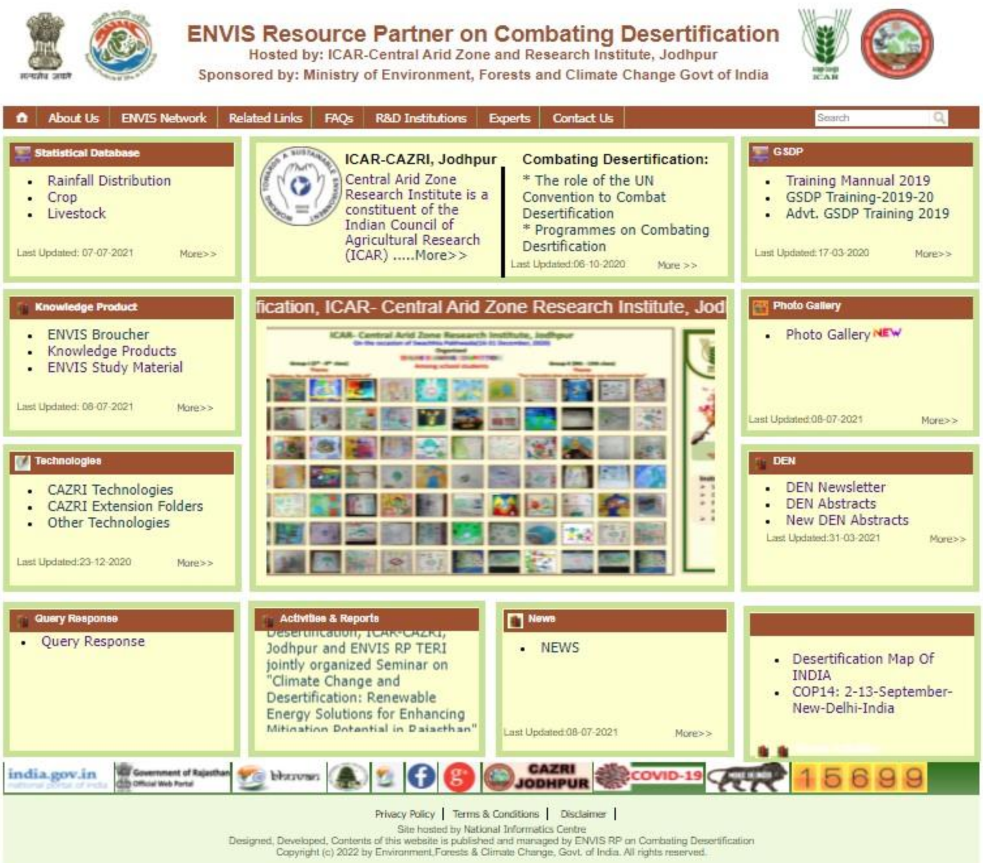
Celebrated World Environment Day on June 5, 2021 jointly with ENVIS Hub, Assam through a webinar on this year's theme "*Ecosystem Restoration*". The webinar was inaugurated by Smt. Kimnei Changsan, Director, ASTEC, Assam. Dr. O.P. Yadav, Director, CAZRI, Jodhpur in his opening remarks highlighted that lot of positive changes have occurred in western Rajasthan specially in case of sand dune stabilization and improved production which has been possible only through community participation and opting scientific technologies. The Guest Speaker Dr. P. C. Moharana, Principal Scientist & ENVIS Coordinator, ICAR-CAZRI delivered the talk on " *Ecosystem Restoration – Challenges & Perspectives from Indian Arid regions in Rajasthan*" Sh. Abhay Kumar Johari, IFS, Former Special Principal Chief Conservator of Forests, Member Secretary, Assam State Biodiversity Board shared his views on this year theme specially restoration activities in their area. The webinar was attended by 100 participants.


World Day to Combat Desertification and Drought

Celebrated World Day to Combat Desertification and Drought Day on June 17, 2021 through a webinar on the theme "*Restoration. Land. Recovery.".* Dr. O.P. Yadav, Director, ICAR-CAZRI, Jodhpur released a poster on desertification. He highlighted the impact of implementation of various scientific interventions like sand dune stabilization, silvipasture development, integrared farming systems, and quality seed supply by the institute to combat desertification. The Guest Speaker Dr. Ajai, Professor and Formerly Group Director, SAC, ISRO, Ahmedabad gave his presentation entitled "*Desertification: Mapping, Monitoring & Restoration*" and discussed the causes and means of combating of desertification in the past and present. He cited examples of temporal changes in degradation process from different parts of India as well as from African countries. The webinar was attended by scientists and officials from ICAR-CAZRI, ISRO and other ENVIS centres.



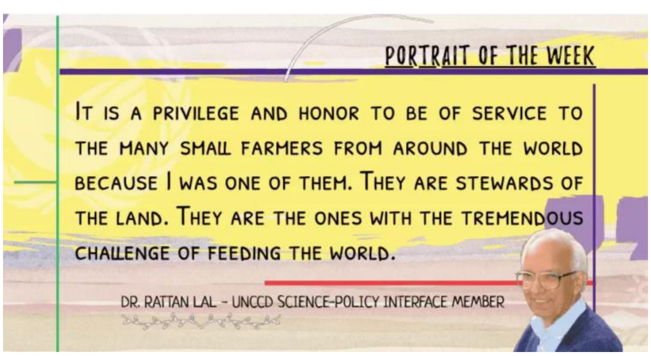


Information Around

Portrait of the week: Rattan Lal

5 FEBRUARY 2021 | STORY | SUSTAINABLE DEVELOPMENT GOALS | SUSTAINABLE LAND MANAGEMENT & RESTORATION

This year UNCCD Science-Policy Interface member Dr. Rattan Lal has received the prestigious civilian Padma Shri Award from the Indian government for his revolutionary research in the field of soil science, which helped millions of smallholder farmers produce larger yields while taking better care of their land. The innovative soil-saving techniques developed by Dr. Lal have helped improve food and nutritional security of more than two billion people, saved hundreds of millions of hectares of natural tropical ecosystems, promoted restoration of degraded soils and aided in reducing global warming. Dr. Lal's achievements have been previously recognized by the World Food Prize.



Land restoration pathways to a green recovery. Restoring land creates numerous benefits in terms of food production, water regulation, climate, biodiversity and ecosystems, employment, infrastructure, and governance. Positive feedback loops would initiate and scale up land restoration.