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Soil Science in the Thar Desert

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ABSTRACT: Thar Desert, arid region of rolling sand hills on the Indian subcontinent. It is located partly in Rajasthan state, northwestern India, and partly in Punjab and Sindh (Sind) provinces, eastern Pakistan.

Rajasthan, India: Thar Desert vegetation

Scrub vegetation in the Thar (Great Indian) Desert, western Rajasthan, India.
The Thar Desert covers some 77,000 square miles (200,000 square km) of territory. It is bordered by the irrigated Indus River plain to the west, the Punjab Plain to the north and northeast, the Aravalli Range to the southeast, and the Rann of Kachchh to the south. The subtropical desert climate there results from persistent high pressure and subsidence at that latitude. The prevailing southwest monsoon winds that bring rain to much of the subcontinent in summer tend to bypass the Thar to the east. The name Thar is derived from thul, the general term for the region's sand ridges.

KEYWORDS: soil, Thar, desert, science, sand, texture, type

I. INTRODUCTION

The Thar's desert sands overlie Archean (early Precambrian) gneiss (metamorphic rocks formed between 4 billion and 2.5 billion years ago), Proterozoic (later Precambrian) sedimentary rocks (formed about 2.5 billion to 541 million years ago), and more-recent alluvium (material deposited by rivers). The surface consists of aeolian (wind-deposited) sand that has accumulated over the past 1.8 million years.

The desert presents an undulating surface, with high and low sand dunes separated by sandy plains and low barren hills, or bhakars, which rise abruptly from the surrounding plains. The dunes are in continual motion and take on varying shapes and sizes. Older dunes, however, are in a semi-stabilized or stabilized condition, and many rise to a height of almost 500 feet (150 metres) above the surrounding areas. Several playas (saline lake beds), locally known as dhands, are scattered throughout the region.[1,2,3]

The soils consist of several main groups—desert soils, red desertic soils, sierozems (brownish gray soils), the red and yellow soils of the foothills, the saline soils of the depressions, and the lithosols (shallow weathered soils) and regosols (soft loose soils) found in the hills. All those soils are predominantly coarse-textured, well-drained, and calcareous (calcium-bearing). A thick accumulation of lime often occurs at varying depths. The soils are generally infertile and, because of severe wind erosion, are overblown with sand.

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The amount of annual rainfall in the desert is generally low, ranging from about 4 inches (100 mm) or less in the west to about 20 inches (500 mm) in the east. Precipitation amounts fluctuate widely from year to year. About 90 percent of the total annual rainfall occurs during the season of the southwest monsoon, from July to September (see also Indian monsoon). During other seasons the prevailing wind is the dry northeast monsoon. May and June are the hottest months of the year, with temperatures rising to 122 °F (50 °C). During January, the coldest month, the mean minimum temperature ranges between 41 and 50 °F (5 and 10 °C), and frost is frequent. Dust storms and dust-raising winds, often blowing with velocities of 87 to 93 miles (140 to 150 km) per hour, are common in May and June.

Thar Desert: khajri tree

Khajri (khejri) tree (Prosopis cineraria) at Harsawa in the Thar Desert, Rajasthan state, India.(more)
The desert vegetation is mostly herbaceous or stunted scrub; drought-resistant trees[4,6,5] occasionally dot the landscape, especially in the east. On the hills, gum arabic acacia and euphorbia may be found. The khajri (or khejri) tree (Prosopis cineraria) grows throughout the plains.

The thinly populated grasslands support blackbucks, chikara (gazelles), and some feathered game, notably francolins (partridges) and quail. Among the migratory birds, sand grouse, ducks, and geese are common. The desert is also the home of the endangered great bustard.

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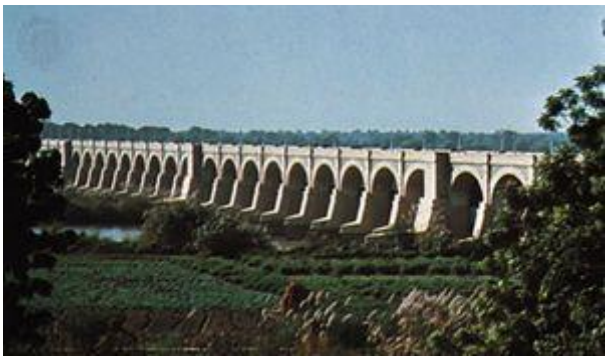
People

Hindu pilgrims

Hindu pilgrims gathering at Pushkar, in the Thar Desert, Rajasthan state, India.
Most of the desert's inhabitants reside in rural areas and are distributed in varying densities. Both Islam and Hinduism are practiced, and the population is divided into complex economic and social groups. The prevailing languages are Sindhi in the southwest, Lahnda in the northwest, and Rajasthani languages—especially Marwari—in central and eastern portions of the Thar. The ethnic composition of the Thar is diverse. Among the most prominent groups are the Rajputs, who inhabit the central Thar. Many nomads are engaged in animal husbandry, crafts, or trade. In general, the nomads are symbiotically related to the sedentary population and its economy.
Economy



Section of the Sukkur Barrage irrigation project, on the Indus River, southern Thar Desert, Pakistan.

The grasses form the main natural resources of the desert. They provide nutritive pasturage as well as medicines used locally by the inhabitants. Alkaloids, used for making medicine and oils for making soap are also extracted. There are five major breeds of cattle in the Thar. Among those the Tharparkar breed is the highest yielder of milk, and the Kankre breed[7,8,9] is good both as a beast of burden and as a milk producer. Sheep are bred for both medium-fine and rough wool. Camels are commonly used for transport as well as for plowing the land and other agricultural purposes. Where water is available, farmers grow crops such as wheat and cotton.

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Rajasthan, India: Thar Desert well

Well in the Thar (Great Indian) Desert, western Rajasthan, India.
However, water is scarce. Whatever seasonal rain falls is collected in tanks and reservoirs and is used for drinking and domestic purposes. Most groundwater cannot be utilized, because it lies deep underground and is often saline. Good aquifers have been detected in the central part of the desert. Apart from wells and tanks, canals are the main sources of water in the desert. The Sukkur Barrage on the Indus River, completed in 1932, irrigates the southern Thar region in Pakistan by means of canals, and the Gang Canal carries water from the Sutlej River to the northwest. The Indira Gandhi Canal irrigates a vast amount of land in the Indian portion of the Thar. The canal begins at the Harike Barrage—at the confluence of the Sutlej and Beas rivers in the Indian Punjab—and continues in a southwesterly direction for some 290 miles (470 km).

Thermal power-generating plants, fueled by coal and oil, supply power only locally in the large towns. Hydroelectric power is supplied by the Nangal power plant located on the Sutlej River in Punjab.

Thar Desert: camel[10,11,12]

Camel used for transportation in the Thar (Great Indian) Desert, Rajasthan, India.
Roads and railways are few. One railway line serves the southern part of the region. In the Indian part of the desert, a second line goes from Merta Road to Suratgarh via Bikaner, and another connects Jodhpur and Jaisalmer. In the Pakistani part of the desert, a railway line runs between Bahawalpur and Hyderabad.

The partition of India and Pakistan in 1947 left most of the irrigation canals fed by the rivers of the Indus system in Pakistani territory, while a large desert region remained unirrigated on the Indian side of the border. The Indus Water Treaty of 1960 fixed and delimited the rights and obligations of both countries concerning the use of waters of the Indus River system. Under the agreement, waters of the Ravi, Beas, and Sutlej rivers are to be made available to the Indira Gandhi Canal mainly to irrigate portions of the Thar in western Rajasthan.

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II. DISCUSSION

Soil fertility assessment for hot arid regions of Thar Desert in the Indian state of Rajasthan was carried out and on the basis of fertility ratings the soils were classified as low, medium and high. In the present assessment a systematic set of 5655 geo-referenced soil samples across the land use systems viz. rainfed croplands, irrigated croplands and rangelands covering 12 districts of hot arid Rajasthan were collected. The soil samples were analyzed for pH, EC, soil organic carbon (SOC), available P, available K, available Fe, Zn Cu, and Mn. Results of the soil analysis revealed that SOC is low throughout the region, while available P was low to medium, but generally medium to high in available K. Among the micronutrients [13,14,15]Cu and Mn were adequately supplied in most areas, but Zn and Fe were inadequate in large parts. As a whole, SOC, P, Fe and Zn are the major nutrients constraint in hot arid regions of Rajasthan that warrants the attention for development and implementation of soil test based nutrient management plans and application of corresponding nutrients. The Nutrient Index Values (NIV) was low for available P (1.61) and medium for available K (2.14). Amongst the micronutrients NIV for DTPA Zn (1.51) was low, marginal for Fe (1.67), adequate for Cu (2.14) and high for Mn (2.47). The wide spread deficiencies of P, Fe and Zn were most revealing; their deficiencies varies with districts and land use pattern. Irrigated croplands were better endowed than other land uses in respect of SOC, P, Zn and Cu; rangelands in respect of K and Fe, and rainfed croplands in respect of Mn. Key words: Hot arid Rajasthan, major nutrients, micro-nutrients, deficiency, nutrient index value.

III. RESULTS

The Thar Desert is undoubtedly the most inhospitable ecoregion in the Indo-Pacific region; yet still, it supports a human population density of over 80 people per km^2, making it the most densely populated desert in the world. At the same time, the desert supports a relatively rich biodiversity with several large mammals, notably the blue bull, blackbuck, and Indian gazelle or chinkara. They were once the prey for lions and cheetah, which reportedly lived in the southern parts of the ecoregion until the turn of the last century.

This ecoregion lies to the west of the Aravalli Mountain Range in the northwestern Indian States of Gujarat, Rajasthan, extending across the border to the Punjab and Sind regions of Pakistan. It is considered to be the 9th largest subtropical desert. About 5,000 years ago, this desert was the site of Mohenjo Daro and Harappa, ancient cities that supported a civilization contemporaneous with[16,17,18] ancient Egypt, Mesopotamia, and Minoan Crete.

The climate is defined by the extremes. Winter temperatures approach freezing, while summer temperatures soar over 50°C. Rainfall is limited to 100-500 mm from July to September but is mostly unpredictable and erratic.

About a tenth of the ecoregion are sand dunes, while the rest is craggy rock formations and compacted salt-lake bottoms. Unlike other large deserts, there are no oases or artesian wells that provide relief.

The vegetation is unsurprisingly influenced by the extreme climate. The sparse vegetation consists of plants adapted to growing in dry conditions, known as xerophilous plants. These include several kinds of grass and scrub-type vegetation of low trees of Acacia, Prosopis, Tamarix, and Zizyphus. These trees have small leaves with a thick waxy surface to reduce evapotranspiration and save water in hot and dry environments.

Despite the extreme climate, over 40 species[19,20] of mammals live here. Most have evolved and adapted to survive in these extreme conditions. In addition to the larger antelopes and gazelles, there are several smaller species, ranging from the very small antelope rat with long hind legs to carnivores such as grey mongoose, the aggressive ratel or honey badger, desert fox, striped hyena, jungle cat, Indian desert wild cat, and caracal.

The caracal is a medium-sized wild cat that has distinctively large tapering ears with long tufts of hair that exaggerate their length. Adapted to desert conditions, the caracal can survive long periods without drinking water. Their hunting strategy includes jumping about 3 m into the air to catch birds in flight by batting them with their paws. Years ago in India and Iran, caracals were tamed and trained to hunt birds.
Among the 141 birds known in this ecoregion, the great Indian bustard is a globally threatened species whose populations in this ecoregion have rebounded in recent years.

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Grazing by livestock such as sheep and goats is intensive. This affects soil fertility, exacerbates erosion, and destroys the native vegetation. Together with recent climatic changes, these pressures combine to degrade and destroy the fragile desert ecosystems. Nonetheless, the ecoregion has large protected areas where adequate management and protection can be administered to mitigate the widespread threats.

Thus, the priority conservation actions are to 1) improve land-use zoning to mitigate ad hoc and uncontrolled agricultural practices, especially with the availability of irrigation water; 2) control livestock grazing and minimize its impact on the desert ecosystem, and 3) continue to support the conservation effort in the protected areas.

Much of Northern India is made up of huge deposits of alluvium, extending to several thousand feet in thickness in places. It is composed of material washed and eroded down from the Himalayas and from the Northern edges of the Deccan plateau, via glaciers, rivers, landslides etcetera.

It stretches from Karachi in Pakistan, up through the Punjab and around to Delhi, then Eastwards to Bengal, and where adequate water can be guaranteed, they can be amongst the most productive in Asia,Soils are made up of three differing groups of size particles, sand, silt and clay, in descending order of size. Sandy soils can be agriculturally useful, if enough water can be found – they have rapid drainage, and high evaporation rates, too, and can often be lacking in essential minerals.

Clay soils on the other hand hold water well, but can be difficult to work. Clays are the finest particles of all in soils, and water may adhere by molecular attraction to individual particles. They are often found where the sites of old lake beds have been, where the smallest particles have had long enough to settle out in the still water

Silty soils come between the two, they are freely drained, but have a good ability to both take in and hold water; they are also characteristically fertile soils. Alluvium is mainly composed of silt-sized particles.

In Rajasthan in particular, the border areas of the Thar desert can produce good crops. Cotton, millet, wheat, oilseed, pulses and sugarcane[21] are all grown with some success where water is available.

This tends to be where the desert is bounded by rivers, such as the Indus and the Sutlej in the West and North, and to an extent in the South too, where the Rann of Kutch is periodically flooded, even though saline pans are often the only result of such flooding.

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The Vanishing Aravalli Hills

To the East and South, the desert is bounded by the Aravalli hills, which although dry, are able to hold somewhat better supplies of groundwater. As little as 2000 years ago this area was covered with woodland and jungle, which has died out for a combination of reasons, woodcutting, overgrazing and some alteration in the general climate.

The most significant changes in climate though, have been fairly local ones, due to the changes in vegetation. Natural or managed woodlands have broadly similar effects on local climates and soils. Mainly, they act as water reservoirs by providing shade, which reduces water loss; they also cut down windspeeds, which does the same.

They provide humus rich soil, which helps to both absorb and store moisture, and by a combination of these factors produce a beneficial environment for new growth to continue. Part of the problem for Northern India is the extreme seasonality of the rainfall.

It's said that the monsoon hits Bombay within a few days of July the 6th each year. In Northern India generally this spells the time when the only rains of the year will fall, and it all comes in the space of a couple of months, with virtually nothing falling in the rest of the year, including the hottest periods.

Both evergreen and broadleaved woodland can withstand a high degree of seasonality, but other factors are at work. Where overgrazing has occurred over extended periods, vegetation suffers. Goats in particular, will take every scrap of vegetation available, especially the young trees and new leaves. Goats can be found even in the topmost branches of trees, in areas adjacent to deserts all over the world, slowly killing the remaining tree cover, once they have eaten the ground bare.

Coupled with this is the most serious fuel shortage in the world, that of wood. Much of 'the 3rd world' depends on wood for its heating and cooking; few third world villagers have access to, or can afford to use electricity or gas. Labour, though, is cheap and both children and adults spend long hours collecting wood.

Perhaps a couple of days each week for some family members is spent this way, ranging over an ever increasing area. In the quest for fuel, I have seen people literally digging up perfectly good trees by the roots, and these trees offered the only source of shade for some distance around their courtyard. Once the tree cover is thinned out, and the ground vegetation depleted, the sparser woodland dries out more easily, the shade having been removed, and the drying winds able to circulate more thoroughly in the brush.

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Clay pan formation

Winds begin picking up the silt-sized particles, too, since clay sticks together, and sand is too heavy except for the stronger winds. Such water as there is moves more freely through the soil, the lack of organic matter means it dries out more quickly.

The lack of vegetation means that sudden rains tend to wash over the soils surface, since it cannot soak into an extremely dessicated soil. Often a pan will form, sometimes on the surface, composed of baked mud, or a foot or two under the surface, in the form of clays washed through the upper layers of the soil, which now form a waterproof barrier.

Topsoil Erosion

Both of these can accelerate topsoil erosion too. This is how the Thar desert has formed, and the area of totally unusable land continues to increase each year.

The resulting arid region receives less than 10 inches of rainfall in a year, which poses some problems for the creatures which live within it, of which there are surprisingly many. Both insects and reptiles are well represented here, lizards, beetles, scorpions. Then a range of mammals such as gerbils, or the long-eared hedgehog, through to the larger creatures such as the Asiatic wild ass and the camel.[20,21]

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What they all must live on, ultimately, though is the vegetation available in such an area, which itself possesses some interesting features. Most desert vegetation can be classed in two groups. Some such as Mimosa and Cassia and Acacia are equipped with very tough bark to prevent the loss of moisture, even the leaves may have a waxy cuticle.

Others, notably cacti and spurges have very fleshy bodies, but still have a leathery, impermeable skin. Both often show spines in the place of leaves, thus reducing their surface area, and further reducing water loss by transpiration. Some plants protect themselves further by producing a poisonous, acrid sap to deter browsing animals.

Unfortunately, there are some beetles adapted to live on such plants.and they too have inherited the foul-tasting characteristic as their own protection. So plants try to stop water loss, but they must also find new water, because to live, they must lose some of that water in photosynthesis. Very dry soils may only hold tiny amounts of water, adhering to clay particles by magnetic forces.

The power required to gain this water may be phenomenal, and some plants can exert a suction of 150 pounds per square inch, about one and a half times the air pressure in a truck tyre. They do this by concentrating minerals in the root sections of the plant, which causes what is known as a diffusion gradient.

Because forces in nature tend to balance one another out, there is a tendency for things to flow from a weaker to a stronger solution (thereby making the weak stronger, and the strong, weaker !). Osmosis, its called.

Other measures to reach water can be just as dramatic, such as the huge tap roots that Acacias can send down, over 100 feet to any sources of permanent moisture. Yet another strategy can be found in many grasses and herbs, which spread shallow roots over a wide area to take advantage of any dew moisture, which would otherwise evaporate and never reach other plants roots.

In the long term, the survival of any plant species depends on how well it reproduces, and this is of particular importance to desert species. Some may be perennials, in which case they may grow out in colonies of themselves, able to withstand a couple of bad years on their resources, and the main plant can die back, a little, to flourish again when water is more plentiful.

When they seed, they must either produce fewer, larger seeds, which contain enough resources for the plant to become established, or, make the seed in such a way that it only opens when there is water about. Such a seed may remain viable after many years.

Animals which live in the desert show a similar wide range of adaptations, although the changes are related to the sort of animal. Birds, for instance, can travel a long distance in search of water. Sandgrouse will flock once daily at a water-hole, often travelling 50 km in search of it.

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Chestnut bellied male Sandgrouse

Legend had it that this bird carried water back to its young in soaked breast-feather, despite the problem of evaporation on the flight home. Closer study has revealed that the young receive their water in a much more mundane fashion, via regurgitated food.

Most desert birds are small, ground living creatures, often spending large amounts of time in the shade of a rock during the day. They also have to take care when breeding to ensure the eggs or the chicks themselves do not overheat.

Larger birds suffer less from the heat, too, since it is easier for them to circle up to the cooler air on thermal updraughts. One large bird which prefers to run along the ground, though, is the great Indian Bustard, which has well adapted and horny feet for getting about on the stony ground.

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Great Indian Bustard

Unlike many endangered species, which are rapidly losing their habitat, the irony for the bustard is that its habitat is increasing greatly, and it is predation by humans, often sport hunting which threatens their survival.

Generally speaking, the smaller animals have greater difficulty dealing with overheating, since they have a greater surface area relation to body mass, but if its a reptile, then heat poses no real problem until it becomes extreme, and then they merely seek shade.

Small mammals are often not equipped to lose heat via sweat glands or panting, and so they will rarely venture out in the daytime. They stay in burrows where the temperature one metre underground stays around an even 30 C.

Another method to lose heat might be by stilting – lifting themselves above ground, as scorpions do, to allow air to circulate. Or they may be equipped, like the long eared hedgehog with two radiators on its head to lose heat with.

They can usually gain all the water they need from the vegetation they eat. Gerbils in fact can survive on a diet of completely dry food, since they possess the ability to utilise metabolic water. As carbohydrates are digested, they break down to produce carbon dioxide which is expelled in respiration, and water, which is reabsorbed.

The smallest animals, the insects, require virtually no access to water as such, since they lose very little through their hard exoskeleton. Predators can get sufficient water from the bodies of their prey, for instance, or they can get it from the vegetation they consume if they are herbivorous.

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Larger warm blooded animals find less of a problem in dealing with heat, since they possess both sweat glands and the ability to pant and lose heat this way. Unfortunately, both methods use large quantities of water which must be replaced.

Photo Credit: Monsoon magic in Jaisalmer by Shivya Nath

IV. CONCLUSION

To an extent this can be done if the animal has access to large amounts of green fodder, as they may occasionally have after a monsoon shower gets as far North as the Thar, but it normally visits a water hole at frequent intervals.

Camels of course are legendary in their ability to go without water. This is achieved by their ability to tolerate very high levels of dehydration – they may lose 40% of their body weight before suffering ill effects, whereas a loss of 20% would kill most mammals.

The camel can also consume huge quantities of water, (one third of body weight in ten minutes), without ill effect when seriously dehydrated, by an adaptation of the red blood cells. Such sudden and heavy dilution of the blood of a human, for instance, would rupture the red corpuscles, often with fatal effect. Other animals found in the Thar desert include blackbuck, nilgai – or blue bulls, desert fox and wild cat.[21]

REFERENCES

1. Rahmani, A. R. (1989). "The uncertain future of the Desert National Park in Rajasthan, India". Environmental Conservation. 16 (3): 237–244. doi:10.1017/S0376892900009322. S2CID 83995201.
2. ^ Jump up to:[a b c] Singh, P. (ed.) (2007). "Report of the Task Force on Grasslands and Deserts" Archived 10 December 2011 at the Wayback Machine. Government of India Planning Commission, New Delhi.
3. ^ WII (2015). Conservation Reserves Archived 10 April 2015 at the Wayback Machine Wildlife Institute of India, Dehradun.
4. ^ Ghalib, S. A.; et al. (2008). "Bioecology of Nara Desert Wildlife Sanctuary, Districts Ghotki, Sukkur and Khairpur, Sindh". Pakistan Journal of Zoology. 40 (1): 37–43. ISSN 0030-9923.
5. ^ Jump up to:[a b] "Protected Areas". Archived from the original on 3 February 2019. Retrieved 21 April 2019.
6. ^ Ghalib, S. A.; et al. (2014). "Current distribution and status of the mammals, birds and reptiles in Rann of Kutch Wildlife Sanctuary, Sindh". International Journal of Biology and Biotechnology (Pakistan). 10 (4): 601–611. ISSN 1810-2719. Archived from the original on 12 April 2019. Retrieved 21 August 2019.
7. ^ "Lal Suhanra". UNESCO. Retrieved 28 December 2016.
8. ^ "UNESCO - MAB Biosphere Reserves Directory". www.unesco.org. Retrieved 21 April 2019.
9. ^ Champion, H. G.; Seth, S. K. (1968). A revised survey of the forest types of India. Government of India Press. OCLC 549213.

10. ^ Negi, S. S. (1996). Biosphere Reserves in India: Landuse, Biodiversity and Conservation. Delhi: Indus Publishing Company. ISBN 9788173870439.
11. ^ Kaul, R. N. (1970). Afforestation in arid zones. Monographiiae Biologicae. Vol. 20. The Hague. OCLC 115047.
12. ^ Khan, T. I. & Frost, S. (2001). "Floral biodiversity: a question of survival in the Indian Thar Desert". Environmentalist. 21 (3): 231–236. doi:10.1023/A:1017991606974. S2CID 82472637.
13. ^ Raza, Hassan (5 March 2012). "Mithi: Where a Hindu fasts and a Muslim does not slaughter cows". Dawn.
14. ^ Gupta, M. L. (2008). Rajasthan Gyan Kosh. 3rd Edition. Jojo Granthagar, Jodhpur. ISBN 81-86103-05-8
15. ^ "ICMR Bulletin vol.38, No.1-3, Pattern and Process of Drug and Alcohol Use in India" (PDF). Archived from the original (PDF) on 28 March 2019. Retrieved 10 May 2019.
16. ^ "Will Rajasthan opium farmers vote for change?". Archived from the original on 10 May 2019. Retrieved 10 May 2019.
17. ^ "Breeds of Livestock - Tharparkar Cattle — Breeds of Livestock, Department of Animal Science". afs.okstate.edu. Retrieved 5 August 2019.
18. ^ "PlanningCommission.NIC.in". Archived from the original on 14 April 2006. Retrieved 16 November 2009.
19. ^ OilIndia.NIC.in Archived 30 June 2006 at the Wayback Machine
20. ^ "Rajasthan or the Central and Western Rajpoot States, Volume 2, page 197-198". Higginbotham And Co. Madras. 14 August 2018.
21. ^ "Imperial Gazetter of India, Volume 21, page 272 - Imperial Gazetteer of India - Digital South Asia Library". Dsal.uchicago.edu. 18 February 2013. Retrieved 22 November 2013.