CHAPTER II

PROBLEM IN SALINITY OF SOILS AND WATERS OF NORTH GUJARAT
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The existence of the Rann of Kutch is an important factor in shaping the soil characteristics of the regions around it. Its breadth is 80 to 100 miles and length is about 200 miles from Gujarat towards Sind. It is divided into three parts: the Little Rann, the Banni area and the Great Rann.

GEOLOGY AND ORIGIN OF THE RANN

An account of the geology of Kutch is given by Wynne (22). According to Wadia (21), "Jurrassic rocks occupy a large area of the Cutch State. It is the most important formation of Cutch both in respect of the lateral extent it covers and in thickness. With the exception of a few small patches of ancient crystalline rocks, no older system of deposits is met with in this area. It is quite probable, however, that large parts of the country which at the present day are long, dreary wastes of black saline mud and silt, the Rann, are underlain by a substratum of the Peninsular gneisses together with the Puranas. The Rann of Cutch, another tract of the Indo-Gangetic depression, owes its present condition to the geological processes of the pleistocene age."
The Runn of Kutch once formed a part of the sea, and during recent geological epoch two arms of the latter entered the mainland at the Khori Creek and the Hansthal Creek. The Runn was subsequently raised to its present level by later earth movements and thus cut off from the sea(15,21,22). The Runn experienced earth movements even in recent times from the frequent earthquake shocks of 1819, 1844, 1845, 1864 and later years, attended by a fall or rise of the Runn at several places. In course of time the shallow bed was gradually lifted with the silts and clays discharged from the rivers draining into the Runn.

HISTORICAL EVIDENCE

According to Koldich(6), "Over a vast space of the now desert country, east of the Indus, traces of ancient river beds testify to the gradual desiccation of a once fertile region; and throughout the deltaic flats of the Indus may still be seen old channels which once conducted its waters to the Runn of Kutch, giving life and prosperity to the past cities of the delta, which have left no living records of the countless generations that once inhabited them."

"The Runn(4) is almost certainly the raised bed of an arm of the sea, the result of the forces that raised the vast plains of Western India and Sind. Alexander the
Great (325 B.C.) found the Rann a great lake. At the time of Periplus (80 A.D.), the Rann seems to have been fit for navigation, and it seems probable that for nearly a thousand years after, a great part of the waters of the Indus crossed the Rann on their way to the sea. At that time 'Charri' and 'Mirona' on the edge of the Rann between 'Lakhpat' and 'Banni'; 'Bhita'ro' on the west of the Banni and 'Dor'at', Dohi' and 'Phangvado' in the island of Pachham were harbours. The date when the Rann was last navigable cannot be fixed.

It was about 1360 that Hisar Shah's army all but perished in the salt waste of the Kunchi Fan or Rann of Kutch. The fact is patent, Colonel Barton wrote in 1875, that year by year the sea reaches further eastward, and places a few years ago inland villages are open to water traffic."

Thus, "There is considerable evidence to show that an eastern branch of the Indus, namely the Nara or the Koree flowed in historic times through the present Great Rann of Kutch into the Arabic sea and that portions of the Rann were highways of commerce from Kutch to Sind and from Kutch to Rajasthan. There is also evidence to show that parts of the Rann had much more water than they now have and that both the Great Rann and the Little Rann are now drying up. The Rann has been raised above the
bed of the sea by the long continued debris from highlands of Kathiawar and Kutch and the silts and sands from Rajasthan and Sind"(17). "In 1024 A.D. Mahamud of Ghazni destroyed Somnath and later stayed a year in Gujarat. He decided to return to Ghazni by way of Sind across the Rann of Kutch. Here, he encountered deserts, his cavalry was destitute of forage and many of his men died of heat and thirst. A meteor is said to have guided him towards North and finally he found himself on the border of a fresh water lake all full of water. In Nizam-ud-Din's(14) "Akbar" we read that the author who was one of Akbar's generals "crossed over the Rann into Kutch where the Rann was not more than 3 Kos (Kos = three miles) wide and set to work plundering and destroying. We burnt and destroyed 'Kari' and 'Kataria'.....................

After destroying nearly 300 villages in 3 days we recrossed the Rann opposite Maliya and Morvi. Here the Rann was 12 kos wide and we were engaged from dawn to even in the passage. The water was upto a man's navel."

This was in 1584. The first crossing was apparently between Piprala and Lakhapur where the Rann is now 1½ miles wide, and the second between Kutch and Maliya where the present width of the Rann is about 6 miles. It will be useful to ascertain the exact months in which these crossings were made.
The Mara now stops short at the north-western corner of the Great Runn. In olden days, however, the river ran down the western Runn to sea and its inundations watered the low ground north of Lakhpat, forming a fertile rice land known as 'Saira' between Lakhpat and Sindri.

There were frequent wars between the Amirs of Sind and Maharaoos of Kutch and about 1764, after the battle of Jarra, a bund was built across the Koree in Sind by Chulam Shah to divert its water into other channels. In 1802, another effective bund was constructed at Ali Bandar and the waters of the Indus were prevented from entering the Runn. The fertile rice fields of 'Saira' gradually changed into Runn.

The Indus delta is subject to earthquakes. According to Burnes, an earthquake in May 1668 destroyed the town of Samawand in the Indus delta. In June 1819, the great Kutch Earthquake(7) occurred. This was accompanied by a sudden depression of a large part of the Runn north of Lakhpat including the fort of Sindri which was a customs outpost on the banks of the Koree, and a raising of the land further to the north, forming a long elevated mound popularly called 'Allah Band', about 50 miles long crossing the Koree channel transversely. The sinking of the Koree bed round Sindri caused an inflow of sea-water and the formation of a salt lake extending for 16 miles on
each side of Sindri. Sir A. Burnes(8) says that "this embankment was elevated about 10 ft. from the level of the river and is composed of soft clay, mixed with shells, having the appearance of being cut through at some late period, the side being quite perpendicular."

Although occasionally, exceptional floods of the Indus burst into banks and caused the flood waters to cross the Allah Bund, the Sindhis soon repaired the bund and prevented supply of water to Lakhpat.

In 1844, the Sindri lake and surroundings were surveyed by captain Baker. The lake was then 34 miles long and 150 sq. miles in area. In 1907, according to Mr. Sivewright, the lake had completely dried up. Now, of course, with the Sukkar Barrage and the full utilization of the Indus waters in Sind, no water enters the Funn of Kutch.

"Tradition has it that there were many ports both in the Greater Funn and in the Lesser Funn." Examples of such ports are Vavania and Khor on the Kathiawar coast. At Vavania, north-east of Havlakhri, an ancient boat without any iron in it, but with cordage of coir, is reported to have been found at a depth of 15 ft. in the mud in the Funn. Harbours are said to have existed on the Patcham Island in the Greater Funn and at a place called Nerona 20 miles N.N.W. of Bhuj. Sir A. Burnes says that "numerous pieces of iron and ships" nails were thrown up at
Phangwaro (west of Patcham Island) at the time of the great Earthquake.

Wynne (23) states that at one spot on the northern shore of the Patcham, some traces of this old sea have been found in a small patch of sub-recent littoral concrete full of marine-shells. This was clearly in situ resting upon local Jurassic rocks to a height of nearly 20 ft. above the level of the Rann, but sloping towards it.

There is no doubt then, that the Rann of Kutch has been formed by fluvatile deposition of sand, silt and salt and that the Hills of Kutch and Kathiawar have contributed to them and protected the sediments from sea action. The main sources of sediments have been:

(i) The Indus, and perhaps also other rivers between the Indus and the Loonee, now lost in the desert,
(ii) The Loonee,
(iii) The Danas, Saraswati and Rupen falling into the Little Rann, and
(iv) The northward flowing monsoon streams of Kutch and Kathiawar.

GENERAL DESCRIPTION OF THE AREA

Incircling the main land of Kutch to the north, east and south is the Rann of Kutch situated between 20°47' to
to 24°N and 68°26' to 71°10' E, a great salt waste, which covers an area of about 8,000 sq. miles. It consists of two parts called the Great Runn in the north and the Little Runn in the south which are joined by a narrow four mile wide strip between Adesar, location 23°34'N and 70°58'E and Piprala location 23°40'N and 71°05'E. Commencing from the mouth of Khor Creek (Arabian Sea), the Great Runn forms a west to east strip of country of about 180 miles long and varying from 30 to 60 miles in width and comprises a total area of 6,500 sq. miles, including 1,000 sq. miles under Banni. The Little Runn takes its origin from the Hansatal Creek opening into the Gulf of Kutch and runs W.S.W. to E.N.W. It is about 60 miles long, and 5 to 30 miles broad enclosing an area of about 1,500 sq. miles.

**Physiography of the Area (12, 19)**

The mainland of Kutch is an elevated plateau with scattered low bare hills and hillocks, seldom rising above 1,000 ft.; while the Runn of Kutch is not very much above the mean sea level and is almost flat excepting localized minor depressions and elevations. Three types of features are recognised in the Runn. The first is known as Runn, salt soaked plain, which gives its name to the whole tract. The second known as Dhoi or Bet, a sandy soil free from salt, with a cover of grass and occasionally
stunted trees and bushes, is found around the margins of the Runn and islands of various size and the third is known as Kalar or Kala and Lana, a transition between the first and second, with comparatively less content of salt and bears some scattered vegetation. On the higher grounds which have been raised above the flood level by the accumulation of wind borne material, the salt has been washed out by rain and in the larger patches fresh water may be found in shallow wells, though deeper excavations would find only the same salt subsoil water that underlies the Runn. One such large area of grassland, Banni, probably a bank or bar of soil brought down by the north flowing Kutch streams lies south of Patcham island extending westwards along the north of Kutch mainland for a length of about 50 miles and a breadth of about 20 miles. Of the islands in the Runn, the important are Patcham, Khadir and Bela in the Great Runn and Pung in the Little Runn.

An idea of the relief of the Runn may be gauged from the following levels along particular alignments, referred to G.T.S. datum line.
GREAT RUNN

1. Lakhpat to Mogbalbin.... The level is 7 ft. for a distance of 20 miles.
2. Lakhpat to Badin......... The level varies from R.L. 3 to R.L. 5.
3. Hajipir to Allahbund..... The levels in the Runn crossing are likely to be about 8 to 10 ft.
4. Dhori to Kavada......... The levels in the Runn crossing about 3 miles wide are likely to be 10 to 12 ft.

LITTLE RUNN

1. At Malia Crossing....... R.L. about 7 ft.
2. Between Menaba and Vensar............... R.L. is approx. 8 ft.
3. Between Gonthana and Tikar............... The levels are likely to be 8 to 9 ft.
4. Between Adesar and Piprala............... The level at the junction of Great Runn and Little Runn are 12 ft.
5. Across Adesar and Piprala crossing...... 4 to 6 ft.

From the above data it is evident that there is an imperceptible east to west slope in the two Runns. In the Banni area, which is slightly higher in level than the Runn the slope differences are not conspicuous.
The maximum distance of the penetration of sea water in the pre-monsoon period particularly from April to early July is roughly the line Nada bet, Pung island and Khuda in the Little Rann, while in the Great Rann it is to a point approximately 6 miles east of Patcham island. During the monsoon period, a number of rivers, Luni, Banas, Saraswati, Rupen, Phulka and Dhaman from the adjoining territories of Rajasthan and Saurashtra and the streams from the mainland of Kutch discharge their waters into the Rann, the flood water depth varying between one to seven feet in different parts. The strong winds from S.W. and S.S.W. force the sea water into the Rann and due to an admixture with sea water flood water is rendered saline. During the monsoon period the water in the Little Rann at the Mallia crossing which is nearer to the Gulf of Kutch, "remains sweet and drinkable for the first fifteen days of the floods but later slowly turns saline". Near the Bela island of the Great Rann "the water remains sweet only for the first three or four days of the flood". It is said that part of the Banas river water moves slowly north and flows into the Great Rann but Luni water, which is supposed to be partially saline, does not enter the Little Rann. The Banmi area is apt to be under water in times of high flood up to a depth of one foot.
The flood water stands on the ground from early July to end of September. By October the ground is clear of water but the surface remains soft to a varying degree at different crossings till about December. The area remains dry from December to early June. Thus the distribution of the total area of the Runn may be computed as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>Sq.miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banni</td>
<td>1,000</td>
</tr>
<tr>
<td>Area flooded by river waters (Great and Little Runn)</td>
<td>1,900</td>
</tr>
<tr>
<td>Area carrying surface deposit of salt</td>
<td>1,700</td>
</tr>
<tr>
<td>Area under sea-water in Great Runn</td>
<td>1,600</td>
</tr>
<tr>
<td>Area under sea-water in Little Runn</td>
<td>500</td>
</tr>
<tr>
<td>Area now under Pakistan</td>
<td>1,300</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8,000</td>
</tr>
</tbody>
</table>

The data on the total volume of water estimated to flow into the two Runns from the catchment areas during the monsoon period is summarised in Table A.
<table>
<thead>
<tr>
<th>Source of Catchment</th>
<th>Drainage Area (sq. miles)</th>
<th>Average Rainfall (inches)</th>
<th>Run-off (%)</th>
<th>Volume of Run-off (sq. mile ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Great Runn Area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Great Runn</td>
<td>5,372</td>
<td>6</td>
<td>30</td>
<td>3,149</td>
</tr>
<tr>
<td>2 Luni Basin</td>
<td>14,788</td>
<td>16</td>
<td>15</td>
<td>2,957</td>
</tr>
<tr>
<td>3 Banni</td>
<td>1,081</td>
<td>6</td>
<td>18</td>
<td>43</td>
</tr>
<tr>
<td>4 Kutch</td>
<td>2,819</td>
<td>14</td>
<td>12</td>
<td>395</td>
</tr>
<tr>
<td>5 Allabund</td>
<td>783</td>
<td>6</td>
<td>80</td>
<td>178</td>
</tr>
<tr>
<td><strong>Total...</strong></td>
<td></td>
<td></td>
<td></td>
<td>6,722</td>
</tr>
</tbody>
</table>

| **Little Runn Area** |                           |                           |             |                               |
| 1 Little Runn       | 1,474                     | 15                        | 30          | 1,474                         |
| 2 North flowing rivers | 1,635                    | 30                        | 30          | 1,226                         |
| 3 West flowing rivers | 5,830                    | 40                        | 30          | 5,830                         |
| 4 South and Fast flowing rivers | 652 | 15 | 20 | 163 |
| **Total...**        |                           |                           |             | 8,743                         |
From the figures given in the last column of Table A, it is evident that a large volume of run-off water (6,722 sq.mile ft. in the Great Rann and 8,743 sq.mile ft. in the Little Rann) which is now running waste will be available for washing out the salt from soil under controlled and regulated conditions, particularly in the Little Rann."

CLIMATE AND WEATHER OF THE RANN AND ITS SURROUNDINGS (10)

The Rann lies between 23° and 24°N in the subtropical zone of the northern hemisphere and the skies are unclouded except for two months in the year. The maximum temperatures in May go up to 115°F and more. The atmosphere is very dry; even during the monsoon when there are strong west-south-westerly winds from the Arabian sea at the surface, the air above 1/2 km. is generally dry and of continental origin.

The average annual rainfall in the Little Rann is about 15" and in the Greater Rann 10". 92 to 95% of the rainfall occurs in the monsoon months, June to September. The rainfall decreases towards the north-west. Apart from the scantiness of the rainfall, its year to year variability and the variability of its distribution during the season are great. The further west we go, the greater is the
variability of the rainfall. Defining the variability of rainfall as \( V = \frac{d}{R} \times 100 \),
where \( R \) is the mean rainfall and \( d \) its standard deviation, Dr. Ramdas(18) gives the following values of the percentage year to year variabilities of rain in the different monsoon months in Sind, W. Rajasthan and Gujarat.

**TABLE B**

**MEAN MONTHLY RAINFALL (R) AND ITS PERCENTAGE VARIABILITY (V)**

**SIND, WEST RAJASTHAN AND GUJARAT**

<table>
<thead>
<tr>
<th>Region</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( R )</td>
<td>( V )</td>
<td>( R )</td>
<td>( V )</td>
</tr>
<tr>
<td>Sind</td>
<td>0.4</td>
<td>161</td>
<td>2.4</td>
<td>101</td>
</tr>
<tr>
<td>W. Rajasthan</td>
<td>1.1</td>
<td>96</td>
<td>3.4</td>
<td>59</td>
</tr>
<tr>
<td>Gujarat</td>
<td>5.3</td>
<td>62</td>
<td>13.1</td>
<td>47</td>
</tr>
</tbody>
</table>

Most of the rainfall in the Runn and its surroundings is associated with the passage of monsoon depressions or storms across Gujarat. When the depressions are few, or pass too far away from Gujarat, the rain fails.

The suggestion has often been made that the climate of W. Gujarat and Sind has been changing and is even now changing for the worse. It may be worthwhile to summarise the evidence. There is little doubt that 4,000 to 5,000
years ago when the early Indus civilization was still active, there was greater rainfall in Baluchistan and Sind and presumably also in Gujarat. "The reasons for this view have been given by the archeologists of Mohenjo-daro and Harappa. The Indus valley to the south of Mohenjo-daro which is now a sandy desert except in artificially irrigated areas, once supported great cities which used millions of baked bricks in their construction. Fuel and hence forests should have been plentiful. There were rain water drains in the ruined cities. Among the seals are vivid representations of marshland and jungle animals like tiger, elephant, rhinoceros and buffalo, the pictures of the desert animal camel, are scarce. In the Baluchistan hills, there are many ruined irrigation dams near chalcolithic sites implying greater rainfall and sustained effort at controlling irrigation. While it is conceded that part of the deterioration in plant life might be due to human intervention such as the wholesale cutting down of the forests, the desertion of cities and towns due to invasions etc., still the existence of large and civilized settlements for over a thousand years must certainly have meant a more congenial climate than prevails to-day either near Mohenjo-daro or Harappa(3). At the time of Alexander's invasion, Sind was well populated and he had to fight many stiff campaigns on his way from the Punjab to the sea. From
the difficulties he had to experience in his further passage across Baluchistan, it is clear, however, that Baluchistan had even then been arid. More abundant rainfall in Sind and Baluchistan implies either a westward extension of the monsoon or a southward extension of the winter rains.

Coming to the recent past, we have rainfall data extending for a number of stations in Gujarat to over 70 years and for a few stations to 100 years. The rainfall data of the whole of north-west India have been examined by Dr. Banerji(1) and Dr. Pramanil(16) and for Gujarat by Dr. Desai(2). Dr. Desai concludes that "there is no persistent tendency to decrease over Kala Gujarat during the period under consideration", Considering the rainfall averages for all the years for which data are available up to 1886, 1920 and 1940, Dr. Banerji found that there was a significant progressive decrease of rainfall in N.W. India and an increase in E. Rajasthan, Madhya Pradesh and Uttar Pradesh. Examination of the 10 years running means of rainfall for stations in Saurashtra and Kutch however shows that while there was a slow decrease in rainfall from 1850's to 1900-05, there was again an increase in the period 1915-30. From the evidence at present available, we can only say that there are certain long-period fluctuations in the general circulation of the atmosphere which leads to
oscillations of the Indian monsoon, but cannot say either that there is a progressive decrease in the monsoon rainfall or assign a definite period for the oscillation.

From the middle of April the temperature rises and the maximum temperature is recorded in May and June. The highest and the lowest temperatures recorded at Bhuj are 111°F and 60°F respectively. The rain-factor and N.S. Quotient for the Great Rann region (Bhuj to Budin area) are low and characteristic of a semi-desert and semi-arid climate, while the climatic conditions in the Little Rann (Bhuj to Jamnagar) are nearer to arid or semi-arid conditions.

**VEGETATION OF THE AREA (11, 19)**

Vegetation of Kutch is described as desert vegetation by Hardy (1913); Semi-desert by Unstead; poor steepe land by Johnstone and tropical thorn forest by Champion (1936). There are scattered thorn forests in Kutch. In the Rann proper there is no vegetation but in the Banni tract, camel bush, a small Euphorbeaceous shrub or coarse grasses and groves of babul (Acacia species) are the characteristic vegetation.

Only extremely xerophytic vegetation can survive in this area. Two major ecological divisions are: arid region where vegetation is very poor with vast barren areas and
semi-arid region where plants of the most xerophytic type are found. De Martonne (1926) has employed index of aridity to delimit the different vegetational zones on the earth. According to him, indices below 5 characterize the true desert from botanical point of view, indices about 10 correspond to the dry steppe, those of 20 more or less to prairies and above 30 to forest vegetation. The index of aridity for Bhuj is 9.3. The most important crops of Kutch are bajra (Pennisetum typhoideum) and cotton.

Cultivation terminates a few miles from the edge of the Rann.

It has been a belief with many people that the Rann of Kutch is extending its territories.

Some additional evidence regarding existence of sea water and its land locking are: (i) the formation of Lake Nal by the silting up of the old sea of Kutch and the old sea of Cambay, resulting into vast tracks of saline land in Dhal Pradesh and Nal Kantha(20), (ii) occurrence of underground reservoirs of Petrol Oil at Navagam, Kacchi, Shertha, Dholka, Mehsana(13), (iii) occurrence of under waters of tube-well of North Gujarat, Dhal Kantha and Nal Kantha, with geochemical type Na-Mg-Cl-SO, resembling the sea water geochemical type(13).

Thus occurrence of vast track of saline land in the
Little Rann of Kutch and the adjoining parts of North Gujarat is responsible for huge saline track in the districts of Radhanpur, Palanpur and Mehsana.

Again irrigation has been expanded on a very large scale by drilling tube-wells from 200' to 1000' depth in this semi-arid region. Irrigation by salty water of tube-wells has also created a problem of salinity in many parts of Radhanpur, Palanpur and Mehsana.

We have made many field experiments to examine the use of waste sulphuric acid from Dairy and acid-slurry industries for reclamation of saline-alkali soils.

Dudhsagar Dairy located at Mehsana collects about 5 lak. kilograms of milk every day and utilize about 2 to 2.5 tonnes of sulphuric acid for milk-testing.
REFERENCES


7. Ibid 5, pp. 16.

8. Ibid 6, pp. 322.

9. Ibid 5, pp. 11-12.

10. Ibid 6, pp. 324-326.


