CHAPTER 9
9.1 Introduction

Salt water intrusion into the confined and unconfined aquifers along various coastal belts of India is being increasingly reported (Basak, and Vasudev 1983). The problem is particularly severe in the coastal tracts of Tamil Nadu and Gujarat. Due to the increasing demand for potable water resources the limited groundwater resources of these sensitive zones are being more extensively utilized compared to the last decade. In many places particularly in Tamil Nadu coast, this has resulted in a gradual lowering of water table causing the sea water wedge to intrude further into the land (Basak, and Vasudev 1983). Withdrawal of such fresh water from the shallow unconfined aquifer adjacent to shore, particularly in the absence of appropriate recharge in the non-monsoonal season, cause lowering of the freshwater table. This lowering of water table is met with the landward advancement of the seawater interface and thus reducing fresh water storage space and also partially increasing the salt content of the potable water due to transverse or lateral diffusion from sea water.
In Kozhikode coast the salt water intrusion takes place from the sea, which is hydraulically connected to the coastal aquifer. This chapter presents the study on groundwater quality deterioration caused by salt water intrusion along different coastal stretches of Kozhikode. For this two year's observations (See Ch. 8) on the wells are analysed and correlated with depth-to-water level and distance of the well from the sea shore using a simple conceptual model. The possible impact of predicted sea level due to greenhouse effect is also discussed.

9.2 The Ghyben - Herzberg Model

The basic concept of sea water intrusion in coastal aquifers is provided by Ghyben - Herzberg (Todd, 1959) and is shown in Fig.(9.1).

According to this the quantitative relation between the freshwater table and the position of seawater interface (Fig.9.1 and 9.2),
is expressed as

\[
\frac{h}{H} = \frac{D_f}{D - D_s}
\]

\[h \quad - \quad \text{depth of freshwater in the aquifer}\]
Fig. 9.1 Sea Water Intrusion in the Coastal Unconfined Aquifer and Ghyben Herzberg's Relation

Sea

Fresh Water

Saline Water

Sea water interface

\[ h = \left( \frac{D_f}{D_s - D_f} \right) H \]

Fig. 9.2 Probable Density Distributions in the Fresh Water Lens Above the Sea Water Interface
H - depth of freshwater above the sea level

D - density of fresh water (gm/cc)

Ds - density of sea water (typically 1.025 gm/cc).

Physically, this equation signifies that for every unit drop of fresh water table there is \( \frac{D}{D - D_s} \) times rise of sea water interface, thus severely restricting the available quantum of fresh water. The typical value of the factor \( \frac{D}{D - D_s} \) is of the order of 40. What happens to the quality of fresh water consequent to this rise of sea water interface is not adequately studied.

The sharp interface between fresh and saline water as depicted is only simplification of the actual situation. In reality there exists a transition zone of certain width where the density varies between that of seawater to fresh water. The density distribution will be similar to what is shown in Fig. 9.2. The density of water is proportional to the dissolved salt content in it. This means TDS (Total Dissolved Solids), chloride and other salt content distribution across the freshwater lens (Fig.9.2) will also be of the same nature of that of density distribution. Hence, it is obvious that the average density \( (\bar{\rho}) \) and consequently average TDS, chloride and salt content of the
floating freshwater lens will be dependent on the thickness of freshwater lens available at that point. Fig. 9.2 is self explanatory in this respect. Keeping this in mind, it is perhaps logical to expect the following:

(a) at any point of time average salt content of the freshwater lens should increase as one approaches the shore,

(b) at all points in the coastal aquifer salt content should increase with the lowering of freshwater table,

(c) the rate of increase of salt content with the lowering of fresh water table should increase as one goes nearer to the shore and

(d) beyond a certain critical distance from the shore, salt content of the freshwater lens should be independent of the depth-to-water table and it's temporal fluctuations.

9.3 Salinity Intrusion in Kozhikode Coast

In Kozhikode coast the low-lying areas are mostly threatened by seawater intrusion problem. These low-lying areas found in
Aliyur near Mahi river, Kottakkal near Kottakkal port, Puthiyaniirathukadavu near Elathur, Kothi near east Kallayi and Kadalundikadavu in the southern part of the coast. Seasonal variation has been observed in salinity in wells located in the above mentioned areas.

9.3.1 Ways of salt water intrusion

Salt water intrusion in the fresh water lens can occur in a number of ways. Firstly, according to the Ghyben-Herzberg principle the position of the interface depends upon the flow of groundwater and the outflow of water from the edge of the lagoon or island. Fluctuations in the size of the lens occur with saline intrusion at the lens margin when the lenses contract. The coastal wells located at Kadalundikadavu and Kottakkal are partly influenced by lagoon and partly by seawater as they have sea on one side and lagoon/backwater on the other.

More localised saline intrusion can occur as a result of over-pumping and also due to effect of tides. The well no. KB2 situated at Aliyur near Mahi river is affected by salinity due to tidal water from the sea and also over-pumping from nearby well. Again assuming the Ghyben-Herzberg relationship, the effect of
over-pumping in a shallow well is to drawdown the water table. If the water table is drawn by 0.03 m, this will result in upconing of the interface at the base of lens by 1.2 m (i.e. 40 times the amount of drawdown).

The third way in which salt can intrude the coastal aquifer is by overwash also called freeboard washover (Roy and Connell, 1989). If storm water overtops the seaward beach ridge the sea water will flood the coast and shallow wells existing on the shore will become saline. Frequent outwash may result in increase in salinity.

9.3.2 Seasonal salinity variation

To understand the variation of salinity levels, in the coastal wells chloride variation map of different coastal stretches are prepared based on the chemical analysis data obtained for the permanent observation wells for pre-monsoon, monsoon, and post-monsoon periods.

Fig.9.3 shows the chloride variation along Aliyur - Kottakkal stretch. The chloride level is found to be >5000 ppm in well no. KB2 which shows intrusion of sea water in wells in the area during summer. In other seasons the chloride variations are
FIG. 9.3 CHLORIDE VARIATIONS OF WELLS ALONG KOZHIKODE - COAST (Aliyur - Kottakkal Stretch)
found to vary between 25 and 50 ppm.

Fig 9.4 indicates the chloride levels of wells in ppm in Kottakkal - Kollam stretch. In this stretch at Kottakkal coast at well no. KQ7 indicates more than 150 ppm of chloride during pre-monsoon. In other season in general chloride variation of well is found to vary from 10 to 30 ppm. At Kadalur, laterite hills are abutting the coast hence the salinity of wells are found to be minimum. Increase in chloride variation is noticed towards the Morat river and also towards the sea during summer season.

Chloride variation map of Kollam - Korapuzha stretch in different seasons are presented in Fig. 9.5. Analysis of the data indicates that in this stretch also wells adjacent to Korapuzha and towards sea shore an increase of chloride (more than 50 ppm) during pre-monsoon. In other seasons, the general chloride level in this stretch is found to vary between 10 ppm and 20 ppm.

At Korapuzha - Kallayi coastal stretch, the high content of chloride is recorded near Elathur which lies close to the Korapuzha estuary, Canoli canal and sea. In pre-monsoon season the wells located at this stretch indicate a variation of more than 300 ppm in chloride levels which is noticed towards sea and near Korapuzha at Elathur. In other wells the chloride level
Fig 9.4 CHLORIDE VARIATION OF WELLS ALONG KOZHIKODE COAST (Kottakal-Kollam Stretch)
Fig 9.5 CHLORIDE VARIATION OF WELLS ALONG KOZHIKODE COAST (Kollam-Korapuzha Stretch)
varies from 200 to 300 ppm in pre-monsoon, 50 to 200 ppm in monsoon and 50 to 150 ppm in post-monsoon period. Fig. 9.6 shows the general variation of chloride levels along Korapuzha - Kallayi coastal stretch.

Kallayi - Kadalundikadavu forms southernmost part of Kozhikode coast. The chloride level variation of open wells along this stretch is presented in Fig 9.7. The variation of chloride is found to vary from 50 to 200 ppm in pre-monsoon and in other seasons the chloride levels vary from 20 to 50 ppm.

9.3.3 Estimation of seawater length

Spatial and temporal variations of groundwater salinity are also studied in the open wells selected for quality studies. The study is significant as the fresh water lens in the shallow unconfined aquifer is floating over the sea water wedge of the type described in Fig 9.2. General direction of fresh water flow is from the eastern uplands to the sea in the west.

For studying seawater intrusion studies 6 wells are chosen as experimental wells from among the 36 permanent observation wells along the coast. The distance of these wells from the shore is measured. In the wells the T.D.S., chloride and
Fig 9.6 CHLORIDE VARIATION OF WELLS ALONG KOZHIKODE COAST (Korapuzha-Kallayi Stretch)
Fig 9.7 CHLORIDE VARIATION OF WELLS ALONG KOZHIKODE COAST (Kallayi-Kadalundikadavu)
conductivity are measured for two years. For each depth-to-water level corresponding T.D.S and chloride values are plotted. From these plots width of sensitive zone lying the Kozhikode coast is estimated.

The depth-to-groundwater table and the two salinity parameters (TDS and Cl) were measured during April - May, July - August and December - January, representing the pre-monsoon and post-monsoon seasons. Table 9.1 presents the season-wise average values for TDS, chloride and water levels of coastal wells for two years.

For each depth-to-water level measurement corresponding TDS and Cl values are plotted for different coastal wells, (Fig. 9.8 and 9.9). The slopes of these plots indicate rate of salinity ((TDS or Cl) change with change of depth of fresh water table and are termed here as "Quality - Depth Index (QDI)". These indices tell the well user, the likely amount of rise or drop of salinity per unit lowering or rise of depth-to-water level. Higher QDI indicates higher sensitivity of the freshwater towards the change in depth-to-water table. The distance of the observation wells from the sea shore are plotted against the QDI for TDS and Cl in Table 9.1 and Fig 9.10.
Fig. 9.8 VARIATION OF TDS WITH WATER TABLE ALONG KOZHIKODE COAST

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>SYMBOL</th>
<th>WELL NO.</th>
<th>DISTANCE FROM SHORE</th>
<th>QDI IN ppm/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>○</td>
<td>KK 52</td>
<td>60</td>
<td>2000</td>
</tr>
<tr>
<td>2</td>
<td>⌂</td>
<td>KQ 7</td>
<td>70</td>
<td>1428</td>
</tr>
<tr>
<td>3</td>
<td>△</td>
<td>KB 19</td>
<td>100</td>
<td>338</td>
</tr>
<tr>
<td>4</td>
<td>⋄</td>
<td>KK 26</td>
<td>200</td>
<td>297</td>
</tr>
<tr>
<td>5</td>
<td>○</td>
<td>KK 6</td>
<td>600</td>
<td>118</td>
</tr>
<tr>
<td>6</td>
<td>□</td>
<td>KB 2</td>
<td>150</td>
<td>59</td>
</tr>
</tbody>
</table>

Fig. 9.9 VARIATION OF CHLORIDE WITH DEPTH TO WATER TABLE ALONG KOZHIKODE COAST

<table>
<thead>
<tr>
<th>SL NO.</th>
<th>SYMBOL</th>
<th>WELL NO.</th>
<th>DISTANCE FROM SHORE</th>
<th>QDI IN ppm/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>○</td>
<td>KK 52</td>
<td>60</td>
<td>800</td>
</tr>
<tr>
<td>2</td>
<td>⌂</td>
<td>KQ 7</td>
<td>70</td>
<td>475</td>
</tr>
<tr>
<td>3</td>
<td>△</td>
<td>KB 19</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>⋄</td>
<td>KK 26</td>
<td>200</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>○</td>
<td>KK 6</td>
<td>600</td>
<td>58</td>
</tr>
<tr>
<td>6</td>
<td>□</td>
<td>KB 2</td>
<td>1500</td>
<td>14</td>
</tr>
</tbody>
</table>
Table - 9.1 Season-wise average values for TDS, chloride, and water levels of wells along Kozhikode coast

<table>
<thead>
<tr>
<th>Sl.No.&amp; Well No</th>
<th>Distance from Sea in m</th>
<th>Season</th>
<th>Average depth in m.</th>
<th>Average to water level</th>
<th>Average TDS in ppm.</th>
<th>Average Chloride in ppm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 KB-02</td>
<td>2400</td>
<td>Pre-monsoon</td>
<td>2.72</td>
<td>114.18</td>
<td>2523.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>1.52</td>
<td>35.00</td>
<td>155.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>2.37</td>
<td>76.90</td>
<td>9.00</td>
<td></td>
</tr>
<tr>
<td>2 KB-19</td>
<td>80</td>
<td>Pre-monsoon</td>
<td>2.73</td>
<td>578.00</td>
<td>85.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>1.67</td>
<td>332.00</td>
<td>58.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>2.36</td>
<td>602.00</td>
<td>62.00</td>
<td></td>
</tr>
<tr>
<td>3 KQ-07</td>
<td>70</td>
<td>Pre-monsoon</td>
<td>0.88</td>
<td>651.00</td>
<td>150.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>0.83</td>
<td>287.00</td>
<td>50.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>0.80</td>
<td>144.00</td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>6 KK-06</td>
<td>100</td>
<td>Pre-monsoon</td>
<td>3.44</td>
<td>966.00</td>
<td>167.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>2.08</td>
<td>1273.00</td>
<td>571.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>2.80</td>
<td>986.00</td>
<td>160.00</td>
<td></td>
</tr>
<tr>
<td>7 KK-25</td>
<td>200</td>
<td>Pre-monsoon</td>
<td>0.95</td>
<td>1033.00</td>
<td>188.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>0.23</td>
<td>455.00</td>
<td>50.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>0.80</td>
<td>702.00</td>
<td>35.00</td>
<td></td>
</tr>
<tr>
<td>10 KK-52</td>
<td>70</td>
<td>Pre-monsoon</td>
<td>1.56</td>
<td>759.00</td>
<td>282.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monsoon</td>
<td>1.33</td>
<td>198.00</td>
<td>43.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-monsoon</td>
<td>1.28</td>
<td>317.00</td>
<td>26.00</td>
<td></td>
</tr>
</tbody>
</table>

Earlier (Fig. 9.8 and 9.9) it was seen that salinity parameters (TDS and Cl) in the coastal aquifers vary linearly with the depth-to-water table. As expected, lowering of freshwater table is associated with the deterioration of quality. Experimental areas show that the QDI variation is between 2000.
and 60 ppm/m for TDS and between 800 and 15 ppm/m for Cl₂. Nearer the well to the coast higher the value of QDI. At larger distance from the shore, it is seen that QDI is insensitive to the change in depth-to-water level. This is in conformity with the basic concepts mentioned earlier.

The plots of QDI vs well distance (from the shoreline) indicate an exponential decrease. Based on this analysis, coastal aquifers may be divided into two zones:

(a) Sensitive zone: zone adjacent to shore which is extremely sensitive to the fluctuation of water table. Even a slight variation in depth-to-water table will cause a marked change in the ground water salinity in this zone (Fig. 9.10).

(b) Insensitive zone: Depth-to-water table variation in this zone has only marginal effect on water quality parameters.

The suggested model would be of help to the well users to find out the maximum quantity of water, he can withdraw without adversely affecting the quality of this water as well as it will also be of direct help in forecasting the likely level of
Fig. 9.10 VARIATION OF QDI ACROSS THE COASTAL AQUIFER OF KOZHIKODE COAST
salinity intrusion into the coastal aquifers and device possible remedial measures for the same.

9.3.4 Indiscriminate drilling and associated problems.

After the drought of 1983, there is a tremendous increase in borewell drilling by private agencies in Kozhikode. These activities are mostly concentrated along the coastal stretches of Kozhikode and the adjoining lateritic areas. Most of the private agencies drill borewells in the coast and leave the same without sealing off the saline zones. As a result, there is contamination due to sea water intrusion from the bottom aquifer to the top aquifer.

The location of borewells in and around Kozhikode is given in Fig. 5.1 (ref. Ch.5). Among the studied borehole logs, few borewells tapped in the fractured zones are found saline. The depth horizons of these saline fractured zones encountered in the borewell sites are given below.
<table>
<thead>
<tr>
<th>Location</th>
<th>Fractured zones in m below ground level</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Elathur</td>
<td>70 - 73</td>
</tr>
<tr>
<td>(ii) Arayadathu Bridge</td>
<td>15 - 21</td>
</tr>
<tr>
<td>(Baby hospital)</td>
<td>22 - 30</td>
</tr>
<tr>
<td>(iii) Puthiyara water tank</td>
<td>99 - 105</td>
</tr>
<tr>
<td>(iv) Pachakil Palam</td>
<td>38 - 75</td>
</tr>
</tbody>
</table>

The salinity in these fractured zones may be due to the following reasons:

(a) Ganoli canal passes through these areas in the above mentioned borewell sites and is ending in a small lagoon near Elathur. During summer the tidal water comes from the lagoon through the canal and spreads to the Paddy fields. This saline water trapped in the clay and soil may be percolating down and causing the salinity in these fractures;

(b) These fractured aquifers tapped from the borewells may be extending towards the sea which may be another cause of salinity in the deeper fractured aquifers in the study area.
Similar saline problems are found at Vadakara, Thiruvangur Beypore, Kozhikode beach, etc. Groundwater contamination can be sealed off by putting concrete blocks inside the bore and gradually the hole can be plugged with cement, thus reducing/arresting the salinity permanently.

Identification of sensitive zone is extremely important, because much care has to be taken to maintain minimum possible depth for groundwater table. This can be achieved by a combination of restricted groundwater withdrawal and appropriate recharging in this zone, which will be dealt in detail in the next chapter.

9.4 Sea Level Rise due to Greenhouse Effect and the Coastal Groundwater System.

9.4.1 Sea level rise due to greenhouse effect.

Sea level changes can be broadly divided into eustatic and isostatic. A variety of processes can bring in changes in Sea level. During the last few million years the more obvious and rapid cause of eustatic change has been the glaciation.

Sea level was close to the present between about 35,000 to 25,000 years ago. It then began to recede as the last full
glacial episode began. The maximum drop in sea level was during Wisconsin glaciation. The drop was estimated to be in the order of 75 to 130 m about 18,000 years before present.

Holocene transgression is represented by an extremely rapid rise about 8 mm/year. During the deglaciation period from 10,000 to 7,000 years ago, sea level rose at the rate of 10 mm/year. Since the Holocene transgression, which lasted up to 7000 years ago, the sea level continued to rise at the rate of 1 to 2 mm/year.

Long term tide gauge records demonstrate that the global rise in sea level is continuing (Hicks, 1978; Wyrtki, 1990). Published values for global sea level rise for the last 50-100 years vary from about 1 to 3 mm/year (Douglas, 1991).

The increased emission of 'greenhouse gases' during the last century has brought in dramatic changes in the global climate. It is now expected that the global warming will be of the order of 1.5°C to 4.5°C during the next century (IPCC, 1990).

An accelerated rise in global sea level is generally considered to be the most important impact of global climate change in coastal areas. One of the widely accepted estimates
(IPCC, 1990) of rise in global sea level is 31 to 110 cm by the year 2100, for the low and high scenarios respectively (Fig. 9.11). This is mainly due to thermal expansion of the oceans and melting of glaciers. Such a rate of rise would be 3 to 10 times faster than the current rate.

As a result of present population growth and development, coastal areas are under tremendous pressure. Consequently populated coastal areas are becoming more and more vulnerable to sea level rise and other impacts of climate change. A rise in sea level could increase shoreline erosion, accelerate coastal flooding, inundate coastal wetlands, and other lowlands, increase the salinity of estuaries and aquifers, alter tidal ranges in rivers and bays, etc. Sea level rise could also increase the severity of storm related flooding and consequent salinity intrusion.

It is difficult to predict the effect of sea level rise on the groundwater resources of coast because of uncertainty on three issues:

(a) It is not conclusively estimated at what rate the sea level will rise at a regional level (say, at Kozhikode),
Fig. 9 Global sea level rise, 1990–2100, for Policy Scenario Business-as-Usual (no limitation of greenhouse gases) (IPCC, 1990).
(b) It is still unclear how freshwater lenses behave especially in terms of patterns of flow and

(c) Thirdly, it is unclear what the response of coast will be to sea level rise (Komar etal, 1991).

9.4.2. Saline intrusion in coastal aquifer due to sea level rise

Saline intrusion in coastal stretches of Kozhikode have been described in Section 9.3. Here the same problem is examined in the light of the predicted sea level rise.

If we assume a rise in sea level at the above mentioned rate, let us examine what are its likely effects in various stretches of Kozhikode coast.

(a) Aliyur - Kottakkal stretch

The bed rock topography along the coastal strip is highly undulated. The configuration of the aquifer follows the bed rock topography with crests and troughs as in a wave. Wells located on the crests of the undulations in which the aquifer taps will not be affected. Wells situated on the sloping side (trough side) already have salinity problems,
during summer. This is because of considerable decrease in flow in the river during this period there is salinity intrusion from the high tide waters. This tidal water trapped in the aquifer might have been causing salinity during summer. In future with the sea level rise the tidal impact may encroach into the upper reaches of the Mahi river. This may affect the higher reaches of the aquifer. But as it is observed now this saline water may be washed off during monsoon.

(b) Kottakkal - Kollam stretch

The most important feature of this coastal strip is the presence of rocky hills at Iringal which is a barrier between the lagoon and the sea. The other notable feature is the abutment of laterite hills along the coast. Because of the raised topography of the rock, the wells of this stretch are not saline and in future also there won't be any threat of salinity due to sea level rise in this area.

(c) Kollam - Korapuzha and Korapuzha - Kallayi stretches

In these coastal stretches there are areas prone to saline intrusion. They are found at Elathur and at low lying areas.
adjacent to Korapuzha. Elathur is connected by a canal called Canoli canal which is connected to Kallayi river.

During high tide seawater is pushed into Canoli canal and the saline water entrapped in the clay cause salinity in the study area. Bore hole data reveals that deeper fractured hard aquifer is also saline. Sea level rise can further increase the salinity and hence drilling bore wells should be banned in this stretch.

(d) Kallayi - Kadalundikadavu stretch

In this coastal stretch three main rivers are influencing the ground water system. They are Kallayi, Chaliyar and Kadalundi. All these rivers are influenced by tides. James (1983) indicates that salinity intrusion in the rivers of Kozhikode is limited to about 1 km in monsoon, whereas in summer it propagates up to 15 to 28 km upstream. In the Beypure estuary of Chaliyar a salinity of 5,500 ppm was reported 28 km upstream (Nataraj, 1983). Saline intrusions in coastal aquifers are observed generally in the river bank pockets and along the man made canals connecting these rivers. Sea level rise can induce more salinity in these pockets.
9.5 Summary and Conclusions

Sea water intrusion studies along the coastal belt of Kozhikode region shows the qualitative response of change of depth-to-water table to the change of water quality parameters (TDS and chloride) in the coastal unconfined aquifer. Pattern of variation of quality parameters with depth-to-water level is similar to other coastal aquifers. An exponential decrease of QDI (Quality Depth Index) with well distance (from the sea shore) is observed. The coastal aquifers of Kozhikode can be divided into sensitive and insensitive. The QDI variation is between 2000 and 60 ppm/m for TDS and in 800 ppm/m and 15 ppm/m for chloride. Nearer the well to the coast, higher is the value of QDI. At greater distances from the shore, it is found that QDI is insensitive to the change in depth-to-water level. This is in conformity with the basic concepts mentioned earlier.

The estimated width of sensitive zone in Kozhikode coast extends upto 400 metres from the shore. This zone should be avoided while drilling any deep tube wells or bore wells along the coast. Identification of sensitive zone is extremely important, because much care has to be taken to maintain minimum possible depth for groundwater table. This can be achieved by
combination of restricted groundwater withdrawal and appropriate recharging in this zone. The predicted sea level rise can cause saline intrusion in Aliyur-Kottakkal and Kollam Kallayi stretches. Kottakkal-Kollam stretch will not be affected by sea level rise problems.