CHAPTER - XI

GROUND WATER RECHARGE OF COASTAL AREAS

CHAPTER – XI

GROUND WATER RECHARGE OF COASTAL AREAS

11.0 INTRODUCTION

The coastal areas have very fragile resource base that effects the economy, agricultural and other activities. The basic problem that concerns water is that due to saline intrusion and migration of sea water landwards, the sweet water of fresh water aquifers is turned into saline water in coastal-deltaic plain areas. This phenomenon causes reduction in drinking & irrigation water supplies of usable quality.

The following are the main reasons responsible for salinity ingress of ground water aquifers:

1. Excessive and heavy withdrawals of ground water from Coastal Plain Aquifers
2. Sea water ingress
3. Tidal water ingress
4. Relatively less recharge
5. Poor land and water management

There are many measures like agriculture water management, recharging measures and salinity control measures that are needed to be done in improving water availability and water quality of coastal aquifers. In this manual only recharging and salinity control techniques have been discussed.

Whereas, the recharging methods for coastal aquifer system would include, check dams, recharge ponds/tanks, spreading channels and recharge wells, the salinity control measures that cannot be separated from recharge techniques in coastal areas would include extraction barriers, fresh water barriers, static barriers and tidal regulators.

In case of heavy ground water withdrawal the artificial recharge is to be done by creating storage of fresh water and maintaining of head in aquifers to accelerate infiltration and also by increasing detention – storage time of surface runoff through afforestation and other vegetative measures. The recharging is to be done through recharge tank, check dam, injection wells & water spreading channels/basins as storage methods. The tidal regulators shall prevent upland movement of sea water, while sub-surface ingress can be prevented by creating fresh water heads for balancing sea water head. This can be done through injection well barriers.

11.1 SEAWATER INTRUSION

The situation of over-extraction of ground water in coastal aquifers cause problem of seawater intrusion. The method that is used to control sea water intrusion is to use recharge well barriers through a line of injection tubewells driven parallel to the coast. This mechanism establishes a pressure ridge which pushes the saline front seawards.

A schematic diagram through a confined aquifer system in coastal plain areas and injection well barrier measure for control of sea water intrusion is shown in figure 11.1.

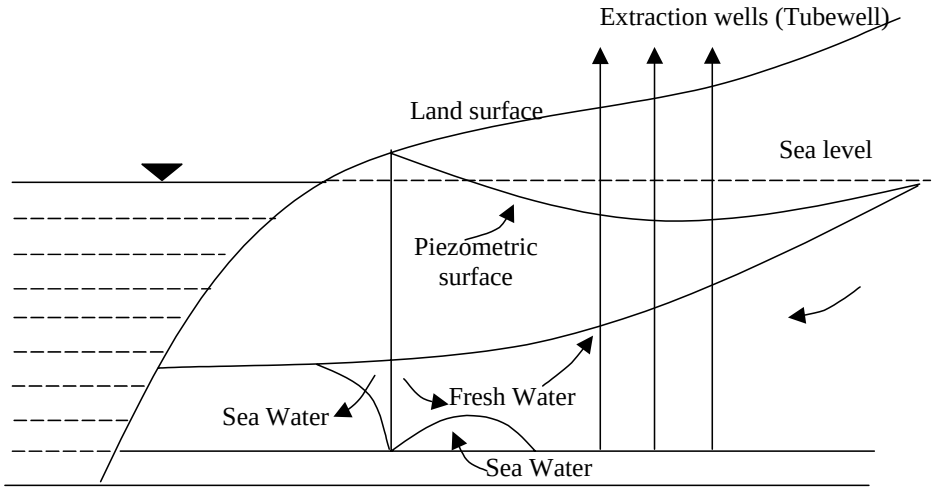


Fig. 11.1 Schematic Diagram of Injection Well Barrier in Confined Aquifer in a Coastal Plain

Recharge of Coastal Plain Aquifers

Various methods are in use world wide for the control of coastal sea water intrusion. In our country very sporadic work has been done as for example in Tamil Nadu (Chennai) and along Saurashtra Coast in Gujarat state (Mangrol-Chorwad-Veraval area).

Methods that can be employed for control of sea water ingress into aquifers are listed and described below:

1. Modification of ground water pumping and extraction pattern
2. Artificial recharge
3. Injection barrier
4. Extraction barrier
5. Sub-surface barrier

(1) Artificial recharge

The efforts here should be to raise the levels of ground water table through appropriate method. The area where unconfined ground water occurs along coastal plain, a surface water spreading method alone should be tried whereas for confined aquifer area, the well recharging method should be employed.

(2) Modification of ground water Extraction pattern

The pumping pattern disturbs the hydraulic gradient whereby it causes landward migration of sea water. It therefore necessitates that the location of pumping wells be changed/shifted. Such wells are required to be dispersed inland to re-establish the ground water flow gradient seawards. Simultaneously it would also suppose to reduce the quantity of pumped water from such wells to produce positive and sweet water effect in fresh water aquifer.

(3) Injection barrier

The intention in this case is to recharge confined aquifer through injection well method whereby water is injected into deep confined aquifer at predetermined pressure through a battery/or line of recharging wells along the coast. The water injected thus under pressure would form pressure ridge along the coast whereby the water shall flow seaward. This would however need very high quality water which if not available nearby should be imported for well injection recharge. A large number of such wells are needed, the number depending up the requirement of a desirable pressure ridge to push ground water seaward.

(4) Sub-surface barrier

In this method, impermeable sub-surface barrier is constructed parallel to the coast but through the extent of fresh water aquifer. This barrier will combat & prevent the inflow to aquifer of sea water. Local method such as clay, asphalt, cement, bentonite etc. can be used to construct barriers.

(5) Tidal regulators

Tidal regulators are required to be constructed to control the discharge of sweet water of river/stream into the sea. Such structures shall have provision to store fresh water for injection and also arrest flow of saline water into river. This will provision fresh water on the other side saline water area along the crest & shall also raise water table in the vicinity of structures.

Ground water monitoring around such recharging and salinity ingress structures is always necessary to keep watch on availability of fresh water/ground water as well as ground water build up for agricultural and drinking water needs.

For tidal regulators, check dams & tanks/ponds, it is advisable to collect detailed information about hydrology, run-off, reservoir level, likely submergence area, command area, geology, geography, soil, drainage network etc. before a suitable design is proposed. A checklist of for such structures in the form of a field format is given below:

CHECK DAM

I. Hydrology

(i) Catchment area
(ii) Analysis of run off/rainfall data
(iii) Estimated design flood
(iv) Out flow

II. Reservoir

(i) Bed level
(ii) HFL/FSL (estimates)
(iii) Capacity

III. Earthen Bund

(i) Upstream/dam shown slops
(ii) Anticipated length & width of dam
(iii) Weir parameters estimates

IV. Regulators

(i) Type
(ii) Discharge
(iii) Size of gate (initially estimated)

TIDAL REGULATORS

A. Hydrology

(i) Tidal catchment area
(ii) Effective catchment
(iii) Rainfall
(iv) Run-off
(v) E.T. losses

B. Reservoir

(i) Anticipated FRL
(ii) Anticipated HFL
(iii) Anticipated gum Capacity at FRL
(iv) Estimates of possible reservoir losses
(v) Expected gross area under submergence

C. Weir

(i) Type of weir
(ii) Possible location
(iii) R.L. of crest
(iv) Length (estimated)
(v) Possible/estimated flood height over crest

D. Dam

(i) Type of earth dam
(ii) Expected max-length of dam
(iii) Upstream/down stream slope

11.2 EXAMPLE FOR COASTAL AREAS

Saurashtra Coast Gujarat

Due to heavy withdrawals of ground water from coastal plain area of Mangrol-Chorwad-Veraval in coastal Saurashtra, ground water depletion has caused sea water to move inland

into fresh water aquifer. Experiments were done under a UNDP assisted CGWB recharge project in which Govt. of Gujarat also participated. As per experiments, the injection well recharge and water spreading methods were employed as means to cause recharge to ground water and to accordingly attempt to control salinity ingress into aquifers. Experiment was conducted to show that while during recharging through pit & shaft methods, a recharge of 192 and 2600 m^3 per day respectively was caused by two methods. It is also shown that tidal regulators in creeks cause stoppage of sea water ingress and forming of lakes behind dams to cause infiltration of water & also ponding in the form of water available as storage for irrigation.

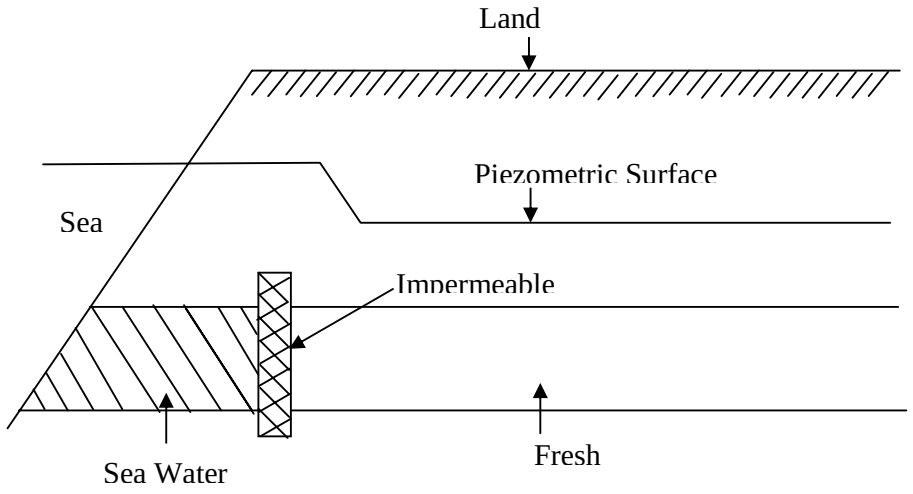
Chennai Coastal Area

The Minjur coastal area in the north of Chennai has been affected by sea water ingress due to excessive lowering of ground water levels caused of heavy withdrawals of ground water. The salinity ingress was observed as much as 8 to 9 km inland from the coast. Experiments pushed the saline water front seaward through check dams & injection barriers under a UNDP assisted - State Govt project of Tamil Nadu.

11.3 PREVENTION OF SALINE INTRUSION IN COASTAL AQUIFERS

Sub–surface Barrier

Given below is an example of a sub-surface barrier constructed along the coast and through the vertical extent of aquifer which effectively prevents sea water inflow into the aquifer. This example is from USA. The material used in construction of barrier includes sheet piling, clay, asphalt and cement grout or plastics etc.



Control of Sea Water Intrusion by an Impermeable Sub-Surface Barrier Along the Coast