## Datasets:

The report uses a number of datasets as follows:

For their analysis, analysts from National Institute of Hydrology have used the following data in the document:

a. Annual Rainfall values at Panaji from year 1983 to 2002
b. Observation well data (Data of wells: quality and concentration of elements)
c. Ground water analysis data

## Data Description and Analysis

The report states that the transformation of coastal tracts of Goa into settlement areas by builders, hotels and other tourist establishments has led to seawater intrusion. Although the magnitude is not serious as of now, the future generation might face a major problem with regard to the availability of fresh water if corrective measures are not initiated at this stage. Therefore, the study performs a simulation of seawater intrusion in a part of the coastal area of Goa and measures its impact and sensitivity parameters due to various ground water scenarios. The study even aims to provide better and sustainable management of water in the coastal area of Goa.

The connection thus established between groundwater and seawater, results in the saltwater or seawater intrusion.

As salt water is denser than the freshwater and has a higher mineral content than fresh water, it can push inland beneath the freshwater.


Fig1: Location of Goa on map

Image Courtesy: Wikimedia

The study also includes various other significant water quality and weather-related databases to support its research work like topography (shapes and features of the region) and agricultural data (types of crop grown).

Several methodologies adopted for the research are:

- ✓ Collection of relevant meteorological (climate and weather information), hydrological (data related to uses and conservation of data) and geochemical(Chemical composition of Earth's crust like composition of elements like Nitrogen Fluoride and Arsenic data.
- ✓ Measurement of monthly groundwater level data in selected 20 observation wells for a year. The level of water was measured at regular intervals in 20 selected observation wells.
- ✓ Bi-monthly groundwater sampling from selected 20 observation wells for a year.
- ✓ Salinity measures of the water in the laboratory.
- ✓ Resistivity profiling and sounding: A known current (direct current or low frequency alternating current) is sent into the ground through a pair of current electrodes and the potential difference created in the medium between another pair of potential electrodes is measured. The calculated resistivity represents the resistivity of the material if the formation is homogeneous and isotropic in nature.
- ✓ Model conceptualization and data preparation.
- ✓ Model simulations and calibration.
- ✓ Model predictions and sensitivity analysis.

## Simulation:

For the simulation study, a finite element model (FEFLOW) was selected, which has the following significant attributes:

- ✓ Flexibility in the spatial discretization (irregular boundaries, coarse discretization), elements can be adjusted to match the geometry, better control on numerical errors.
- ✓ Elements can be oriented along flow, which practically eliminates, numeral dispersion transverse to flow.
- ✓ Coarse discretization can be chosen in areas not affected by the plume (zone of contaminated groundwater containing dissolved contaminants), but important for the flow submodel.

## FEFLOW Method:

The FEFLOW is an interactive finite element simulation model for three-dimensional (3D) or two-dimensional (2D) ground water systems.

The FEFLOW modeling strategy adopts a typical order mentioned in detail as follows:

- ✓ Design super elements: Creation of super elements as bigger units of a model in case of regionally changing parameters or areas of interest.
- ✓ Generate Finite Element Mesh: In case of numerous different super elements to be studied, we can possibly vary the mesh density.
- ✓ Assign the problem attribute data: FEFLOW uses the defaults for a parameter not specified. The borders of the model are impermeable as default.
- ✓ Run simulator: First trial with the model is made.
- ✓ Loop: If the model doesn't work, restart at one of the previous items.
- ✓ Final results: The post processor offers many options for the output of results.

The FEFLOW programming interface and the working window are shown as:

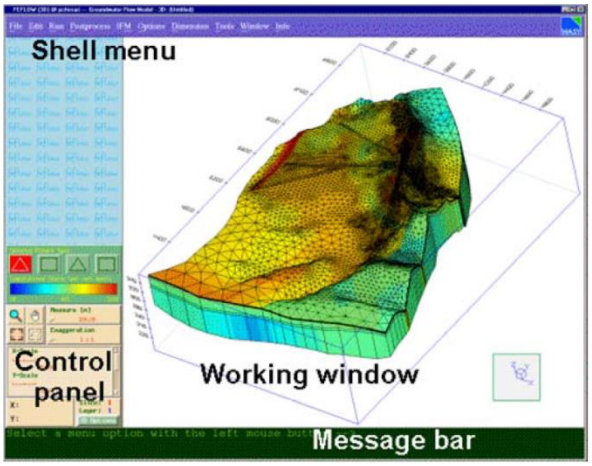


Fig2: FEFLOW programming interface

## Simulation Results:

The simulation results of seawater Intrusion are as follows:

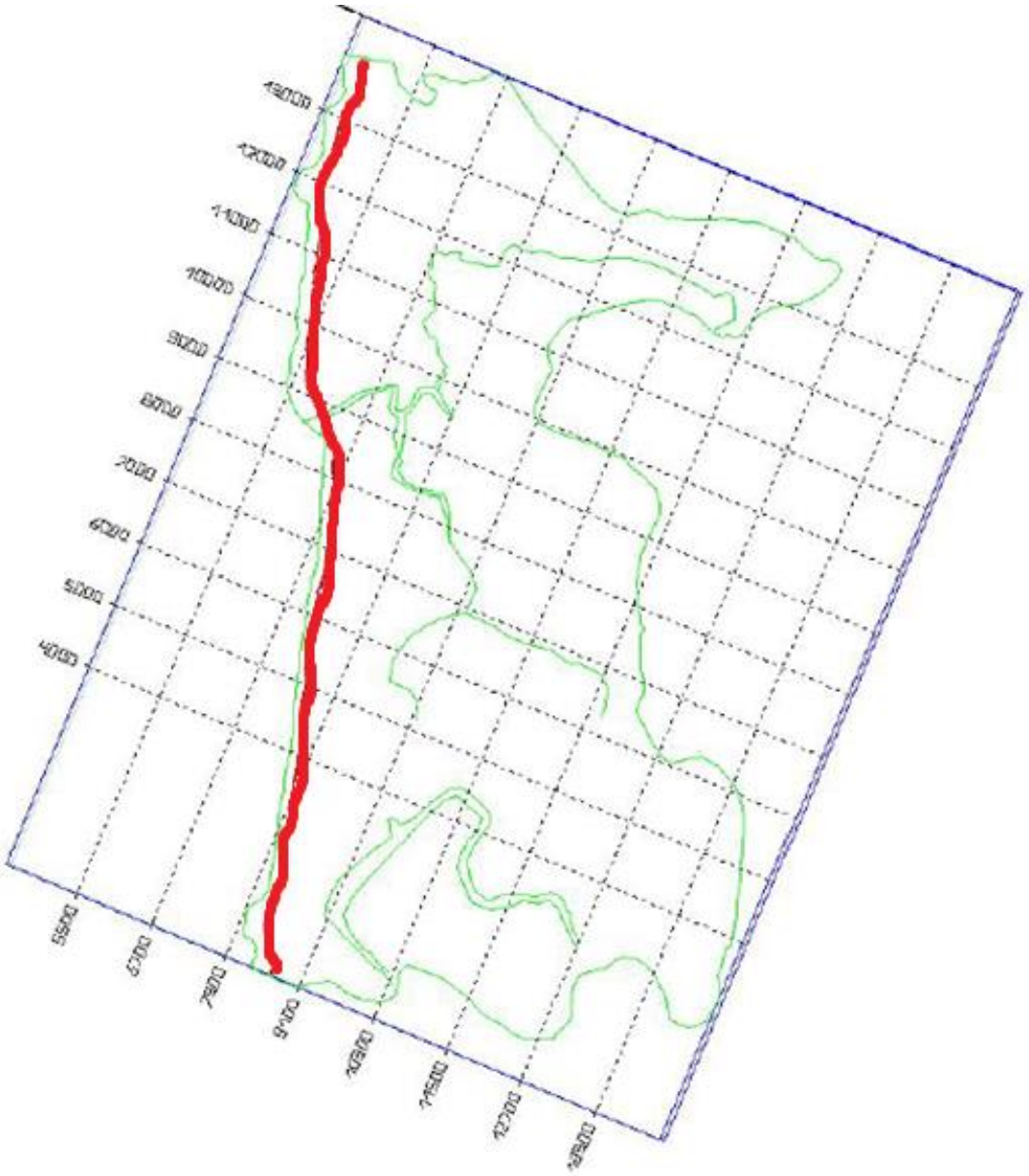

Fig 3: Simulation results of seawater intrusion in GOA

As you can see in the simulation result of the FEFLOW process the areas represented by red line are prone to sea water intrusion. So the possibility of getting the nearby areas affected due to the continuous discharge of groundwater is very high specially in low rainfall years.