CHAPTER VI

DISCUSSIONS AND CONCLUSIONS

The study of groundwater character is an integrated approach; hence the results obtained are nearer to accuracy.
## CHAPTER VI

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DISCUSSIONS

The Asundi Nalla Watershed experiences semi arid climatic conditions. The rainfall and three large and many small tanks form the surface water sources. The water within subsurface i.e. groundwater is other source of water. The surface tanks are seasonal and major part of rainfall is from southwest monsoon. Many months in a calendar year are dry. Plains cover most of the watershed with gentle slopes towards northeast and north.

The litho unit namely greywacke occupies 90% of the watershed. The banded iron formations, shales and argilites are found in southwestern boundaries of watershed. These rocks are of Archean age. Greywackes are hard and compact and less weathered. The primary openings are absent in these rocks. However, the rocks have undergone many episodes of structural disturbances causing many joints and fractures within them. These secondary openings act as water storage reservoirs and act as water carrying conduits. In this process the aquifers are charged through infiltration of surface water. Thus, the groundwater in these greywackes occurs under unconfined or phreatic conditions.

The groundwater is harvested by bore wells and nowadays by deep bore wells. The bore wells are as deep as 136 mts. All the existing dug bore wells are dry and abandoned many years ago. The suggested optimum depth of drilling is 70 to 130 mts for good yield of groundwater.

The watershed is of 5th order basin and follows the laws of Strahler, Horton, Gilbert, Yatsu, Schumm, Chorley etc. The drainage pattern is subparallel to parallel. Drainage characters reveal that the litho units are hard and compact with numerous openings that permit free infiltration of surface water. The soils are also permeable. The hypsometric analysis shows that the watershed is in its mature stage. The sharp changes in direction of flow of stream in ANW may be attributed to possible faults.
64% of the watershed is used for agricultural purposes; fallows cover 16% of the area, 6% of the area is covered by residential area. 12% of the area is covered by sporadically distributed thorny bushes and shrubs.

Based on the satellite imagery study 138 lineaments are identified and 63 possible fault planes are recognised. These lineaments and intersection of lineaments help in infiltration of surface water and storage in the aquifers. The bore wells close to the lineaments yield more water than those away from lineaments, barring a few exceptions.

There is faint relation between yield and depth of bore wells. Five relations are noted viz., yield increases with depth, yield decreases with depth, yield remains same with increase in depth, yield increase in same depth and no relation between depth and yield. This study over watershed shows that yield is high in northern part of the basin.

Water table contour maps show that hydraulic gradient is nearly same in most part of the watershed. This indicates that the subsurface structures are similar throughout the watershed.

The study of water level fluctuation is performed for 27 years data. This indicates a wide variation in the fluctuation of water levels. The Asundi Nalla watershed is considered for development in 1989-1990-1991 by the Minor Irrigation Department, Government of Karnataka. During this period construction of check dams, barriers and plugging of gullies are performed. Due to these structures there is improvement in the recharging of groundwater and in turn increase in the water levels in the bore wells. This is significantly noted by the sharp variation in the water levels after 1991 at 3 observation wells considered for the study in the watershed.

The water management structures developed during 1989-1990-1991 are not in proper order because of their ill maintenance. Therefore it is proposed to
go for fresh management structures. Number of management structures are proposed. Utilizing empirical methods groundwater recharge, groundwater draft, groundwater estimations, stage of groundwater developments and water budgeting studies are performed. These studies have shown that 70% of the watershed is developed and utmost care should be taken for future development.

Groundwater samples are collected from all the villages and 17 groundwater samples are collected from Ranebennur city proper. These samples are analysed and classified using popular methods. Their suitability for agricultural and domestic uses are studied. The chemical characters of groundwater are compared with WHO and ISI standards. These comparative study reveals that most of the samples are hard with high TH values for domestic utility except a few locations. The Durov’s classification classifies the groundwater samples as of moderate quality and most of them are of corrosive nature. Richards’ classification shows that most of the samples are highly saline and low in sodium.

The groundwater when compared for the agricultural utility show that most of the samples are brackish to saline in nature barring a few samples. Therefore, it is suggested to grow salt tolerant crops. The principle component analysis of chemical constituents of groundwater has provided information about the locations of highly saline groundwater wells.
CONCLUSIONS

Based on the details hydrogeological study of Asundi Nalla Watershed (ANW) following conclusions are drawn.

1) ANW experiences semi arid climatic conditions.
2) Greywackes are major litho unit covering more than 90% of area.
3) These rocks do not possess primary openings but possess secondary openings.
4) The secondary openings act as storehouse of water and conduits for the movement of groundwater.
5) The groundwater occurs under unconfined conditions.
6) The average annual rainfall is 516.28mm (average of 15 years).
7) The rainfall is medium to very heavily scattered over ANW.
8) ANW has experienced mild drought for last 15 years.
9) The soils are grey to reddish grey in colour and are permeable.
10) The landforms like structural hills, residual hills, pediplains and fluvial deposits are identified.
11) The drainage pattern is parallel to sub parallel in nature.
12) The basin is of 5th order basin and follows the laws/norms prescribed by researchers.
13) The latitudinal profiles depict moderately steep-to-steep slopes in the southern, western and northern part.
14) Pediplains are with gentle slopes towards north.

15) The longitudinal profiles depict sharp turns in the flow of Asundi Nalla stream, which may be related to possible fault planes.

16) The hypsometric analysis shows that ANW is in its mature stage.

17) There are 138 lineaments, which are in all four directions.

18) 63 possible fault planes are identified, based on satellite imagery.

19) The land cover and land use study based on the satellite imagery reveals the presence of forestlands, fallows, agricultural land, residential areas, rivers and tanks.

20) There are varied relations between depth and yield of bore wells.

21) The bore wells close to lineaments yield more than those away from the lineaments. The yield of bore wells is still higher in the alluvial formations.

22) The bore wells in the northern part yield more water and are deeper.

23) Water table contour maps show that the flow of subsurface water is uniform.


25) Eighty-nine groundwater samples are collected and analysed for major cat ions and an ions. This includes 14 samples from Ranebennur city.
26) Piper’s classification shows that the groundwater samples of ANW are dominated by alkalis and strong acid. The Ranebennur samples are dominated by no cat ion or anion pair exceeds 50%.

27) Back’s classification shows that ANW samples are dominated by Na + K – Ca + Mg cat ion facies and Cl + SO$_4$ – HCO$_3$ an ion facies while Ranebennur samples are dominated by Ca + Mg – Na + K cat ion facies and Cl + SO$_4$ – HCO$_3$ an ion facies.

28) Based on Cl concentration most of the samples are normal chloride water.

29) Based on SO$_4$ concentration most of the samples are normal sulphate water.

30) Based on HCO$_3$ + CO$_3$ concentration most of the samples are normal carbonate water.

31) Most of ANW samples have negative index of base exchange while most of Ranebennur samples are positive index base exchange.

32) Among cat ions Na is dominating over Mg and Ca.

33) Among an ion Cl is dominating over SO$_4$ and Carbonate.

34) Durov’s classification shows most of the samples are of moderate in quality.

35) Gibbs’ classification shows that water chemistry is controlled by the character of litho unit.

36) Corrosivity ratio values shows that many samples are corrosive in nature (both ANW and Ranebennur)
37) The high TH and TDS value restrict many samples for normal domestic uses.

38) Agricultural suitability characters like % Na, SAR show good to doubtful characters.

39) EC and TDS values show that samples are brackish to saline in characters.

40) RSC values show that samples are good for agricultural suitability.

41) KI values show that samples are good to not good.

42) USSL diagram classifies samples as high in salinity and low in sodium hazards.

43) Wilcox’s diagram classifies samples as good to doubtful in characters.

44) NCH concentration shows that most of the samples are unsafe.

45) PI and PS content, the samples are allowable and injurious to satisfactory.

46) Most of the samples can cause incrustation and corrosion to steel pipes.

47) Ayer’s classification for agricultural utility show that most of the samples have increasing problem because of high EC, Cl, HCO₃ values. However the concentration SO₄ is not harmful.

48) The principle component analyses study classifies the highly saline samples from less saline ones.

49) The constituents viz.; Mg, Cl, SO₄, Na and Ca control the concentration of TDS and TH.
50) The groundwater development and management of ANW was taken in 1989–90–91 by Government of Karnataka by constructing various barriers and check dams. These structures are worn out these days because of their ill maintenance.

51) New management structures are suggested for future management of surface as well as groundwater.