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Water Quality Monitoring in the Coastal Area of Trincomalee District

Results of Phase I July 2000 - July 2001

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1. Introduction

Water constitutes the basic resource for life. The water resources of the north eastern coastal aquifer are predominantly used for irrigation and domestic purposes. The ever increasing extraction of water poses a threat to the aquifer and ultimately to the livelihood of communities living along the north eastern coast of Sri Lanka. No reliable longer-term data are available for the quantity of water generated by the north eastern coastal aquifer nor for the possible change of the water quality. Intensive irrigation and a comparatively dense habitat may result in an over extraction of water and a deterioration of the water quality over time. Since IFSP is has a focus on improving the conditions for nutrition and health of the local communities the availability of water of good quality for human consumption and sufficient water for cultivation has become an important issue.

IFSP-GTZ has initiated a combined survey[1] aiming at

- Establishing a monitoring of the quality and quantity of water of the north eastern coastal aquifer and arriving at conclusions for better water management and possible health threats
- Inventorying all agro-wells and common wells north of Trincomalee
- Estimating the safe yield of the aquifer and establishing a water balance.

This report presents the results of the monitoring of the water quality and quantity of agro-wells carried out over a period of twelve months from July 2000 to July 2001. The report presents the analysis and interpretation of the monitoring and compares them with past reported results of studies carried out in the sandy Regosols of the Kalpitiya peninsular in the north west of Sri Lanka. Differences as well as similarities in the results between the two coastal sand aquifers of 'Kalpitiya' and 'Nilaveli-Kuchchaveli' will thereby help to provide a better understanding of the nature and behaviour of the Nilaveli-Kuchchaveli aquifer.

The progress of the monitoring of the water quality and quantity and first findings were reported in a preliminary progress report. However, the main findings and interpretations are given in more depth in this report. The foregoing survey period is referred to as phase I in this report. The subsequent monitoring of 40 selected agro-wells which commenced in July 2001 will be referred to as phase II of the survey and the results will be reported in the year 2002 after a full cycle of twelve months is completed.

The description of the survey area was given in previous reports, and also in the accompanying report on the inventory of agro-wells, and will therefore not be repeated here[2].

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[1] IFSP Technical Paper 16, Water Quality Monitoring in the coastal Area of Trincomalee District. Results of Phase I July 2000 - July 2001, Authors: C.R. Panabokke, S.R.K. Pathirana, Trincomalee & Colombo, May 2002
IFSP Technical Paper 17, Well Inventory in the Nilaveli-Kuchchaveli Area, Author: K. Nadarajah, Trincomalee, May 2002
IFSP Technical Paper 18, North Eastern Coastal Sand Aquifer in trincomalee District, Authors: K. A. W. Kodituwakku, S.R.K. Pathirana, Trincomalee. Colombo, May 2002

[2] IFSP Technical Paper 8, Monitoring of Agro-wells in the Sandy Regosol Area between Nilaveli and Kuchchaveli. First Seasonal Results, Authors: C.R. Panabokke, K.A.W. Kodituwakku, S.R.K. Pathirana, Trincomalee, February 2001

2. Methodology and rationale

The phase I survey was limited to the area of the Nilaveli-Kumpuruppidy (NK) aquifer. A total of 25 agro-wells were selected for monitoring of the water quality and quantity. The locations of the wells represented the three broad sub-regions made up of the (a) main Regosol aquifer sub-region, (b) the transitional sub-region and (c) the residual land aquifer sub-region. The 25 monitored wells were chosen in a manner that they proportionally represented the relative extents of the above three sub-regions. The location and distribution of these 25 selected wells is shown in map 1.

Initially it was planned to measure the electrical conductivity (EC) of the groundwater taken from the test wells at intervals of every fortnight. Due to unavoidable problems this had to be restricted to a monthly interval at certain periods, and thus instead of a total of 24 sampling dates only 17 sampling dates were accomplished during the survey period.

The main emphasis was given to the measurement of the electrical conductivity because this parameter reflects most of the water properties in an integrated manner. Thus a low conductivity value reflects a low concentration of solutes in the water, and a high conductivity value reflects a high concentration of solutes in the water. The depth to the water level (distance from ground level of each of the 25 monitored test wells to the water level of the wells) was also measured at each of the sampling dates. The data provide a broad indication of the seasonal recession in the groundwater table.

Due to the restricted laboratory facilities of the Water Resources Board, the analysis of Nitrates and Chlorides was limited to a total of ten locations that were sampled at one month intervals. Based on the results of the EC, a more detailed sampling was initiated for phase II of the survey.

3. Main characteristics of the Nilaveli – Kuchchaveli aquifer and the Kalpitiya aquifer

3.1 Nilaveli – Kuchchaveli aquifer (N-K aquifer)

The N-K aquifer is located on what geomorphologists describe as a 'raised beach' of unconsolidated coastal sands. These raised beaches are found along the eastern coastal plain of the country with typical locations occurring at Pulmoddai to the north of Kuchchaveli and to the south at Nilaveli and north and south of Batticaloa (Kalkudah and Pottuvil). The main recharge to this aquifer takes place from the November to January rains of the north east monsoon. A small recharge is recorded during the April rains. A schematic cross section of the coastal sand aquifer is shown for the wet and dry season conditions of the groundwater lens in diagram1.

The Nilaveli-Kuchchaveli aquifer as well as the aquifers along the eastern coastal areas are bounded by the sea on their eastern flank and either by a lagoon, mud flats or residual land on their western flank. As a result they can hold the groundwater for a longer period than in the case of the Kalpitiya aquifer which is located on a coastal spit with the sea on both sides (diagram 2).

Due to the past re-working by oceanic currents of the erosional sediments and soil wash from the adjacent land, there is more body or the presence of some fine clay in these coastal sands along the Sri Lankan east coast as compared with the Kalpitiya spit which consists purely of graded coarse sand with no fine material in it. This is also reflected in the infiltration rates reported for the two aquifers. The steady infiltration rate in the Kalpitiya area is between 250cm/hr and 350 cm/hr as compared to the Nilaveli-Kuchchaveli area which is between 65cm/hr and 75 cm/hr.

3.2 Kalpitiya aquifer

The Kalpitiya aquifer is located on what geomorphologists refer to as a 'coastal spit' and is best expressed in this Kalpitiya peninsula located on the western coast of Sri Lanka. A somewhat similar formation is found further north in the Mannar island and also in the Pooneryn meso-peninsula. The main recharge to the Kalpitiya aquifer occurs during the north-east monsoon rains from November to December. As shown in diagram 2 this aquifer is bounded by the sea on both eastern and western flanks. The aquifer mainly comprises of coarse-grain sands, although in some restricted locations it can be clayey. The water table is very shallow. Only 1 to 3m/bgl are recorded with peak water levels occurring during November to January which is associated with the Maha rains.

The aquifer is extensively pumped for both irrigation and domestic water supply, there being no other source of fresh water in this peninsula. Recharge to the aquifer is by direct infiltration from both the rainfall and from return irrigation flows. The highly permeable sands permit an excess of 50 percent of the water applied to the surface to reach the water table.

According to Lawrence et al (1989) '... the groundwater system can be visualised as a series of cells; within each cell groundwater is drawn to the irrigation well and spread over the cropped area where all the rainfall and more than 50 percent of the applied water reaches the water table' (diagram 3). The electrical conductivity of this shallow groundwater varies from 400umhos/cm to 1,500umhos/cm over most of the peninsula, although close to the coastline some high values in excess of 3,000 umhos/cm were recorded.

4. Results of the monitoring

4.1 Introduction

The main rationale for the measurement of electrical conductivity (EC) in this initial monitoring program was to demarcate the different domains of groundwater quality. No comparative study or data is available to date in Sri Lanka of a sequential monitoring of EC values of groundwater in the coastal sand aquifers. A preliminary attempt made in Kalpitiya to monitor 25 wells during the period of September 1981 to July 1982 had to be abandoned half way due to logistical constraints. Instead, the Kalpitiya studies took up the monitoring of Nitrate and Chloride contents of the groundwater.

4.2 Results from July 2000 to July 2001

The location of the 25 wells selected for monitoring of EC values is shown in map 1. As noted in the first seasonal report of February 2001 (IFSP Technical Paper 8), well number NW 02 was excluded from the survey at an early stage because it represents an abnormal situation where the EC values have been consistently in excess of 6,000 umhos/cm, and also because it is located on the residual landscape bordering the lagoon outlet to the sea, which is subject to saline water intrusion at high tide.

After completion of the twelve month period of fortnightly sampling, a broad pattern of variation in the different segments of the Nilaveli-Kumpuruppidi aquifer became apparent. Three broad categories of EC ranges can be recognised. The test wells are grouped accordingly.

Detailed results for all wells according to categories 1 to 3 are given in figures 2 to 8. The well number 01 which shows EC values of more than 2,000umhos/cm is not included in any of the figures.

The monthly rainfall distribution pattern for the foregoing twelve-month monitoring period is recorded in Figure 1.

Category	*Agro-well numbers*	*Figures showing EC trends*	*Average EC (us/cm)*
1	NW 11, NW 14, NW 15, NW 16 NW 17, NW 19, NW 21, NW 22 NW 23, NW 24, NW 25	Figure 2 Figure 3 Figure 4	
2	NW 06, NW 09, NW 10 NW 12, NW 13, NW 18	Figure 5 Figure 6	
3	NW 07, NW 08, NW 20 NW 01, NW 03, NW 04, NW 05	Figure 7 Figure 8	

Table 1: Frequency of EC monitoring

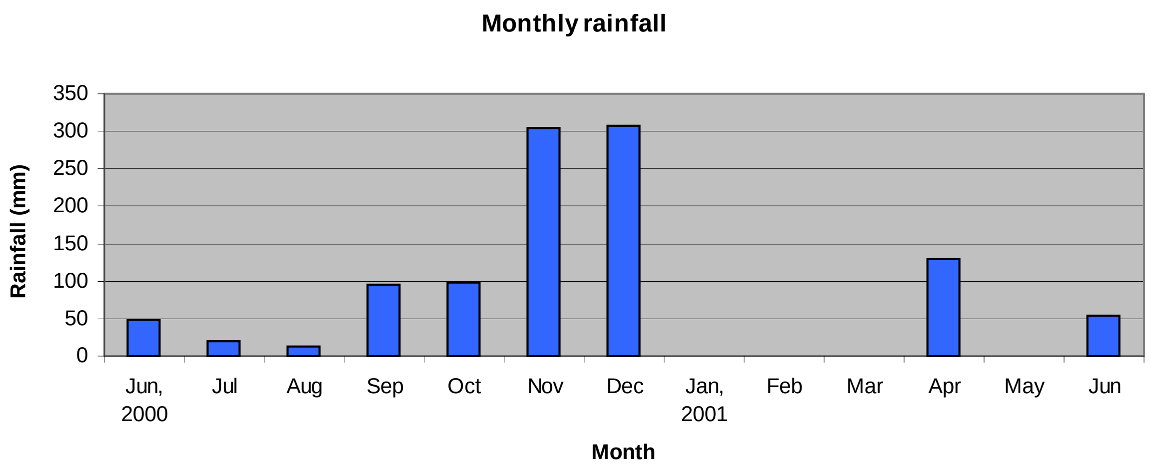

Figure 1: Monthly rainfall 2000 to 2001

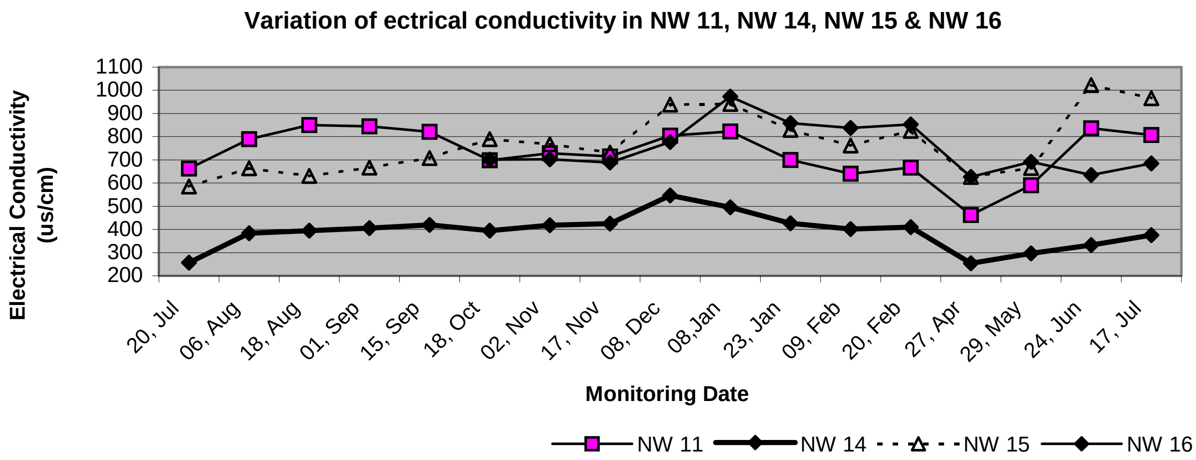

Figure 2: Variation of EC in category 1 (for NW 11, 14, 15,16)

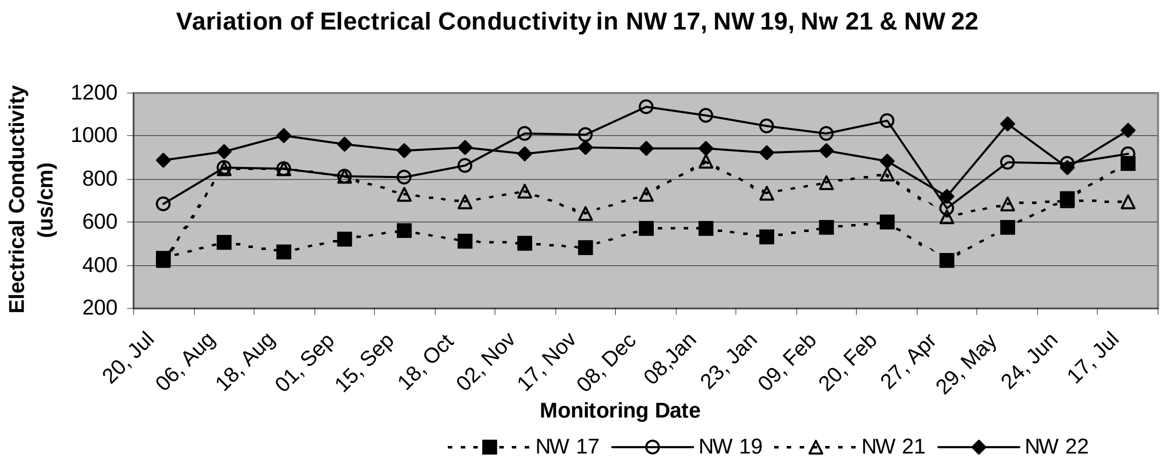

Figure 3: Variation of EC in category 1 (for NW 17, 19, 21, 22)

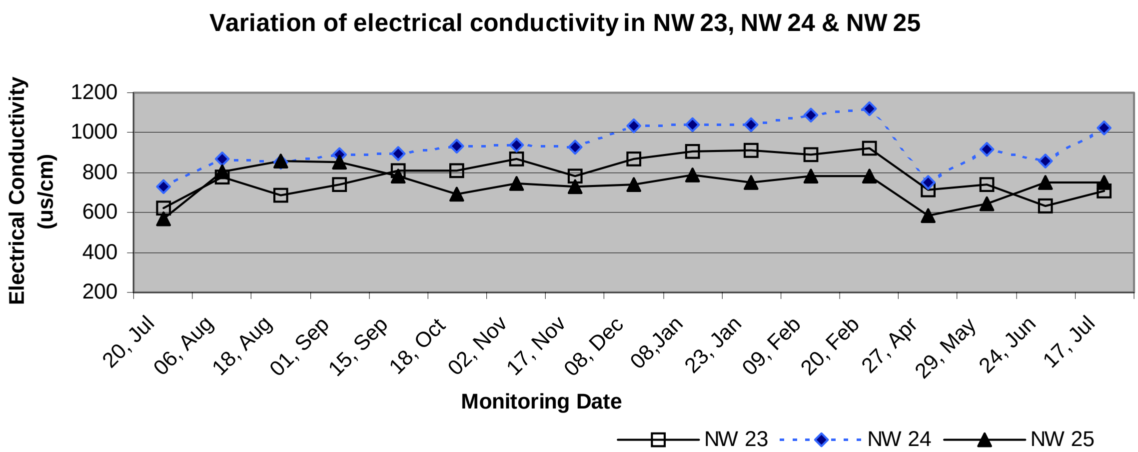

Figure 4: Variation of EC in category 1 (for NW 23, 24, 25)

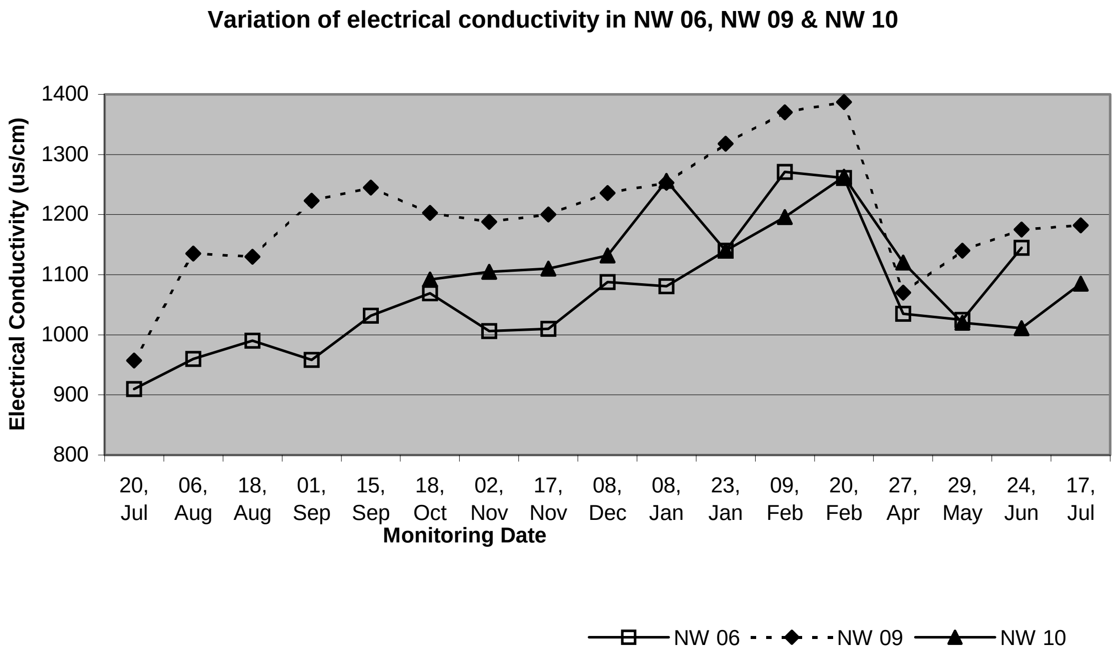

Figure 5: Variation of EC in category 2 (for NW 06, 09, 10)

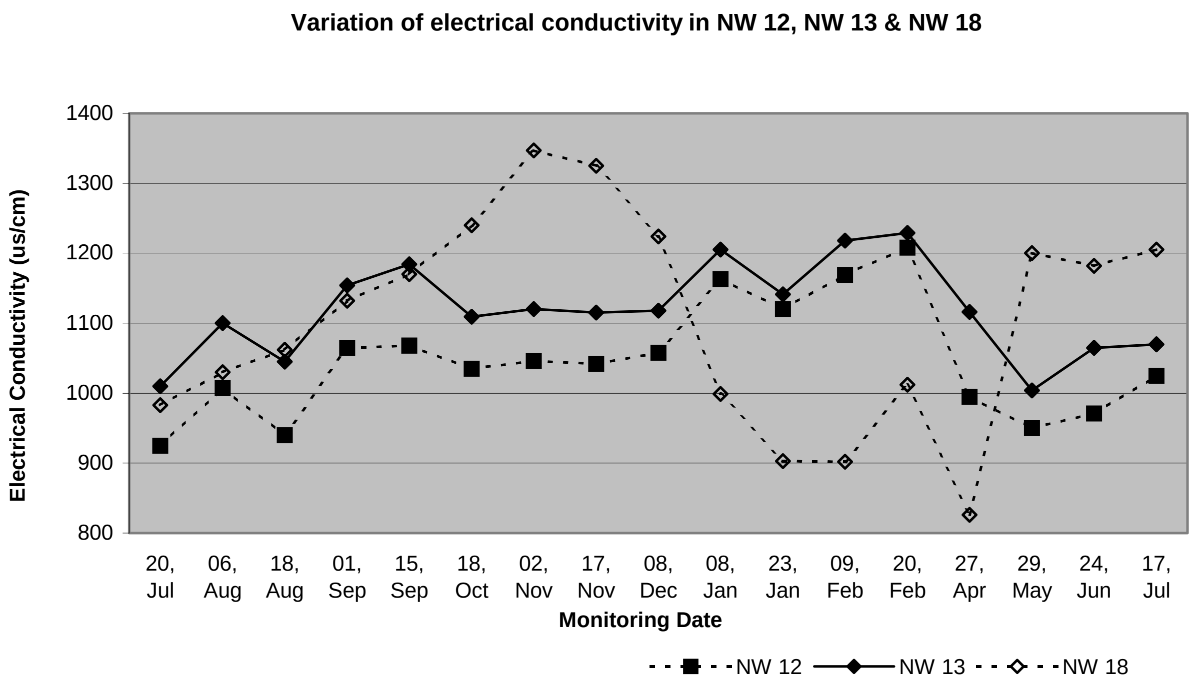

Figure 6: Variation of EC in category 2 (for NW 12, 13, 18)

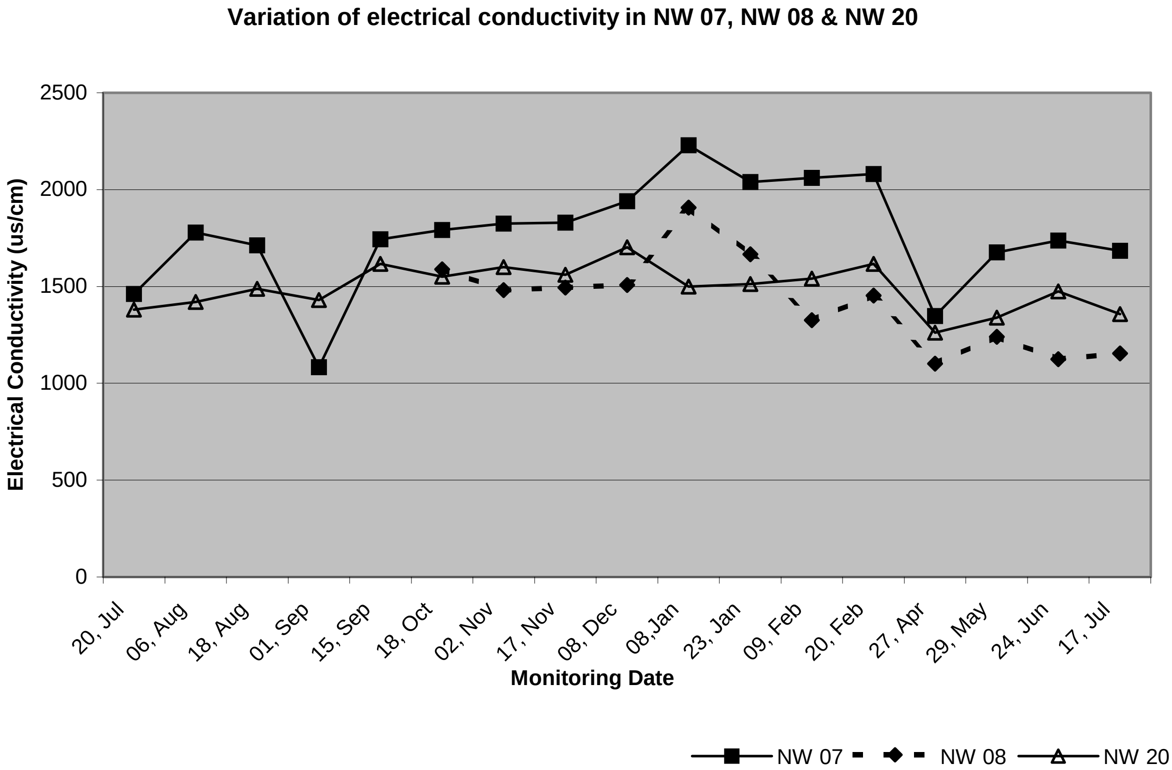

Figure 7: Variation of EC in category 3 (for NW 07, 08, 20)

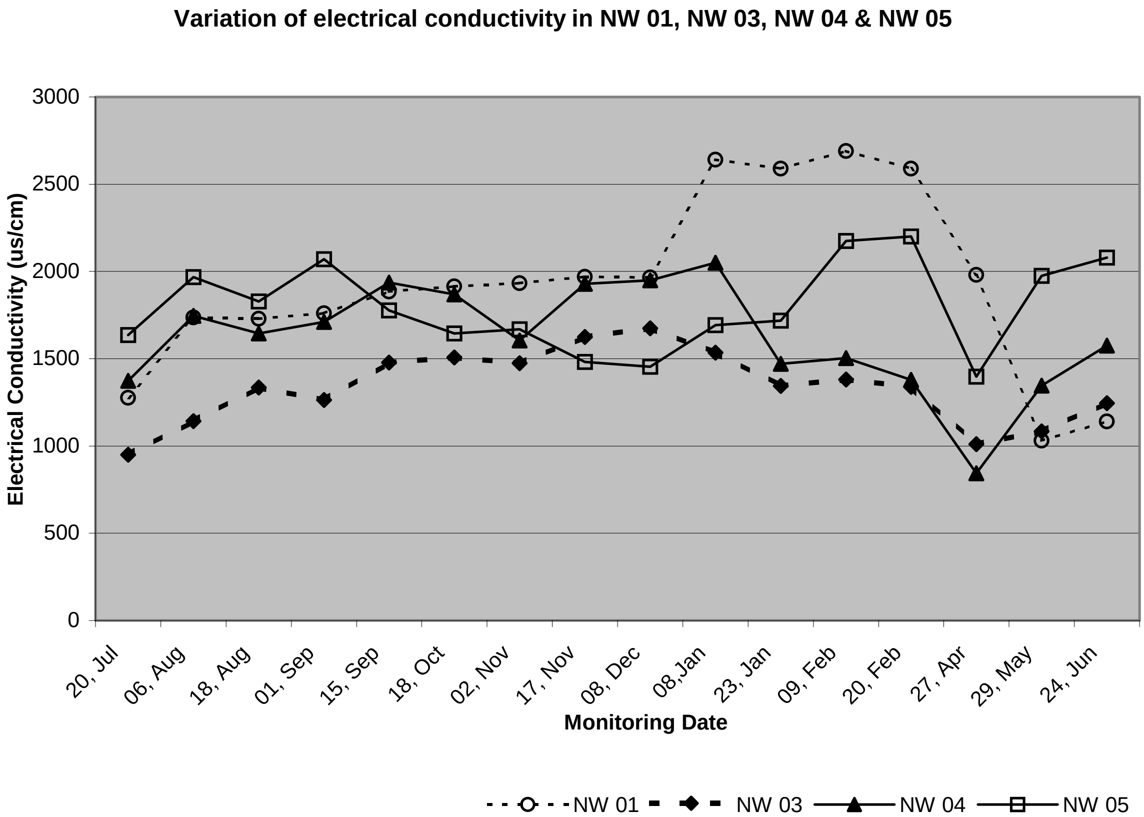

Figure 8: Variation of EC in category 3 (for NW 01, 03, 04, 05)

Looking across all seven figures (2 to 8) showing the variation in EC from 20 July 2000 to 17 July 2001 it could be observed that a small rise in EC for all test wells took place between late July and mid August 2001 in response to the late June rain of <50 mm observed in the year 2000. Thereafter, the EC values remained stable up to the period 17 November although 50 mm of rain was received from September to October 2000.

During the main Maha rains of November a sharp rise in EC at all wells was recorded, except for well no. 18 in category 2 and well no. 3 in category 3. All the other wells in categories 1, 2 and 3 have shown this significant rise in EC for the period from 08 December to 08 January 2000. All wells in category 1 without exception have shown this marked increase in EC from November onwards.

In the subsequent period from 8 January to 20 February 2001 the EC values of all wells in category 1 have remained more or less stable, whilst those in category 2 have shown an increase. For the wells in category 3 the EC values show little change except for well no. 5 which recorded a marked increase. For the period after 20 February 2001, a sharp decline in EC values was observed for all wells consequent to the 100mm of rainfall of early April 2001. After 27 April 2001 the EC values of all wells started to rise, and by 17 July 2001 all wells except a few had reverted to their earlier threshold levels that were recorded in July 2000.

In general, it could be seen that for all three categories of wells a significant rise in EC values of water took place following the main Maha rains in November due to the fact that a large part of the leaching or washing out of the solutes in the soil takes place following these rains. This pattern is followed by a period of stability of EC values from February up to March, especially in category 1, whilst in categories 2 and 3 a smaller degree of change is observed. A sharp decline in EC values is observed during and after the April rains in all three categories of wells followed by a steady rise in EC values up to June. Thereafter the natural equilibrium level is reached at their threshold values.

4.3 Interpretation of results

Comparing the spatial distribution of the eleven wells in category 1, and the six wells in category 2 across the survey area, the best quality water of the Nilaveli - Kumpurupiddi aquifer is present in the area between Gopalapuram – Wallaiuttu – Irakkandi-Kumpuruppidi. The intermediate quality water is present in the area between Nilaveli and Gopalapuram. Water in well no. NW 20 is of poor quality because of its proximity to the sea which results in a higher salinity.

As expected, the best quality water with EC values of between 250mhos/cm and 450mhos/cm is found in wells no. NW 14 and NW 17, which are situated at the higher elevation sites along the central divide of the micro-relief of this ‘raised beach’ Regosol landscape. The poor quality water which is found in wells of category 3 are located in the transitional and residual landform in the region around Sampalthivu, located south of Nilaveli and north of Uppuveli close to the sea.

To summarise, three broad domains of aquifer quality can be recognised in conformity with the three broad geomorphological sub-regions of the (a) main

Regosol aquifer sub-region (b) the transitional sub-region and (c) the residual land aquifer sub-region.

For the seasonal variation in values of the water quality (EC) that are presented in the preceding sub-section 4.2 it is quite evident that a certain cycle of washing out, concentration and subsequent dilution of solutes that have built up over the dry season in the surface soil horizons has taken place following the main Maha season rains. The sequential pattern of washing out, concentration and dilution follows a specific pattern for the three categories identified. For test wells in category 1 which altogether show lower EC values, a well defined sequence of a sharp rise in EC values resulting from the November rains is followed by a period of stability up to March, after which a decline to the threshold level takes place by June.

A similar cyclic pattern is observed for the wells in categories 2 and 3, however, with a slight shift in the onset of the period of concentration and dilution. This is attributable to the higher concentration of solutes both in the soil surface and in the agro-well waters within these two categories.

To conclude, at present there is no evidence of a build up in the concentration of solutes in the agro-well waters and hence in all three categories of these aquifer domains. It could be reasoned that the quantity of the Maha seasonal rains and of the total annual rains received in this region are sufficiently adequate to leach out and dilute solutes that have built up in the soil during the dry season. A threshold equilibrium level is maintained. However, there could be some micro-domains within the main domains that represent a different condition as seen in the intensity of the rise and decline of EC values for well nos. 3 and 18. This aspect is to be investigated more closely in the phase III of the water quality and well monitoring survey that involves altogether 40 agro-wells and domestic wells in the Nilaveli-Kuchchaveli area.

5. Nitrate and chloride content of groundwater

5.1 Nitrate content

The monitoring of nitrate and chloride of the groundwater for ten agro-wells that commenced in August 2000 was continued up to May 2001. The monitoring was limited to only ten wells due to limitations of the laboratory capacity of the Water Resources Board.

Of the wells that were selected for monitoring, well nos. 11, 15, 17, 21 and 23 fall within category 1, and wells 1, 4, 5, 7 within category 3. Figure 9 shows the variation in nitrate content of the five wells 11, 15, 17, 21, and 23. Figure 10 shows the variation in nitrate content of the five wells 1, 4, 5, 7 and 12.

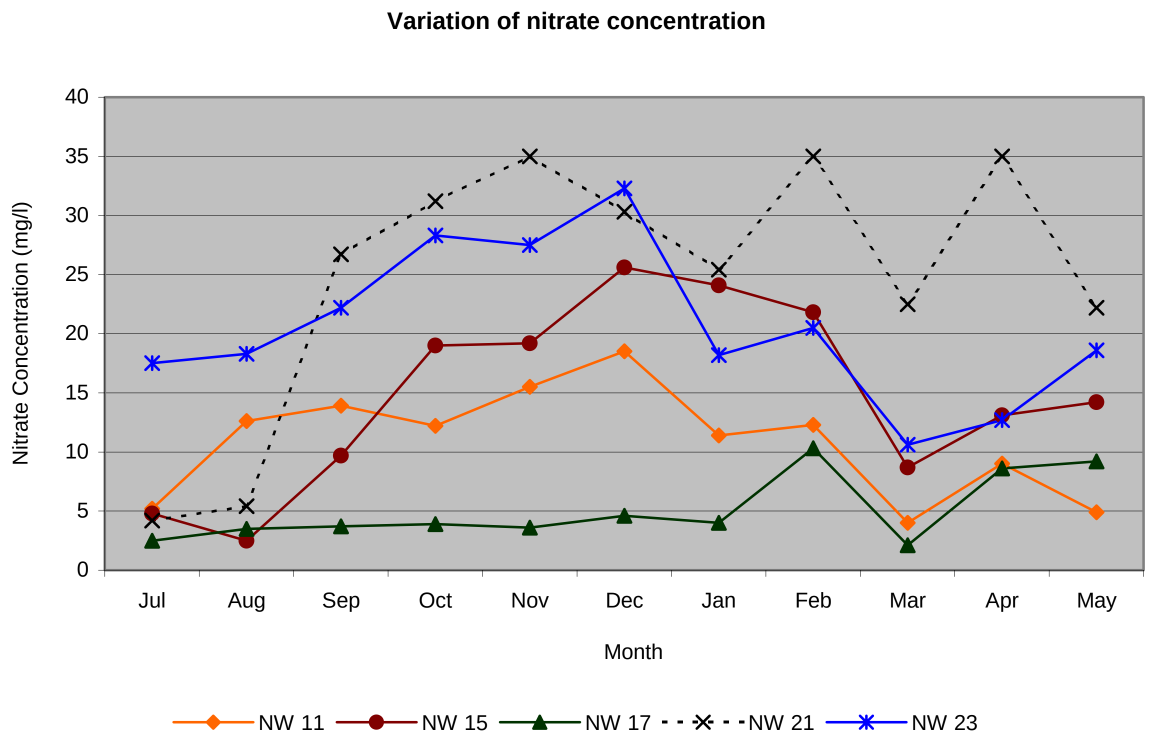

Figure 9: Variation of nitrate concentration at NW 11, 15, 17, 21 & 23

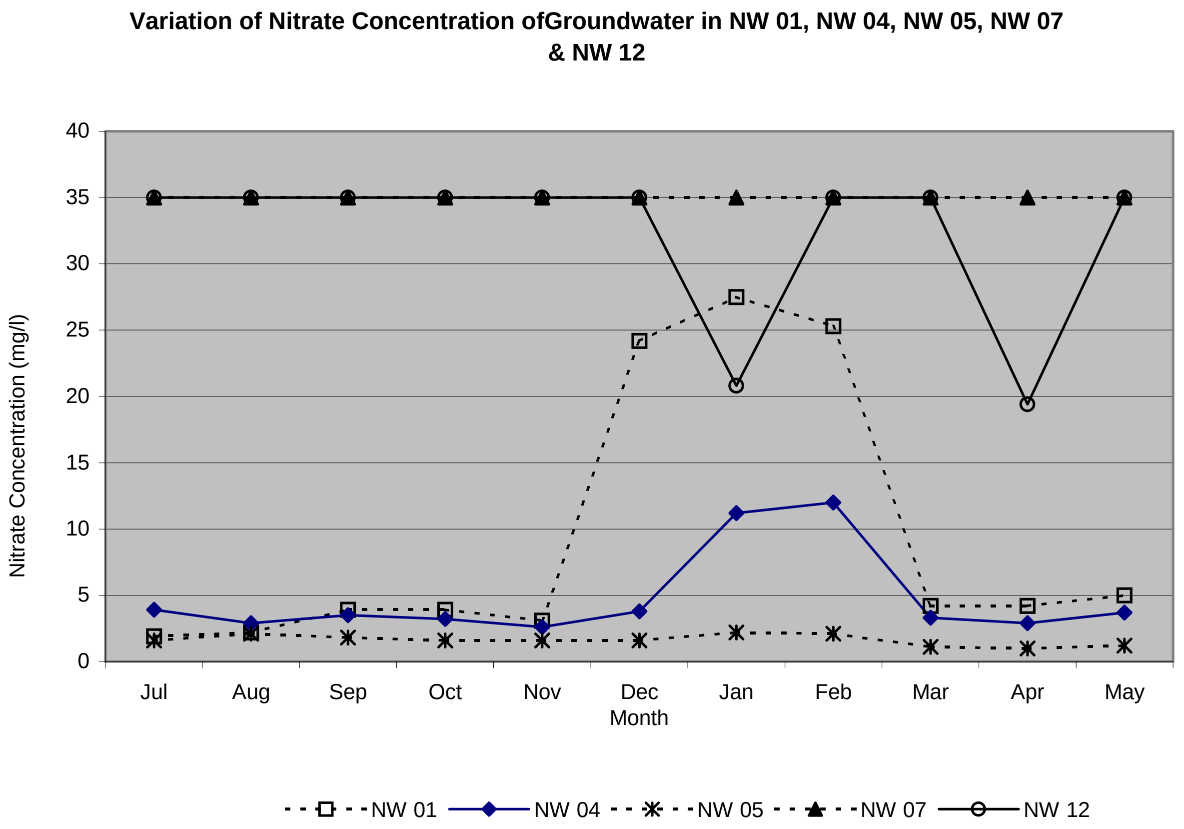

Figure 10: Variation of nitrate concentration at NW 01, 04, 05, 07 & 12

The nitrate content of well nos. 15, 21, and 23 shows a sharp rise in September, and followed by a slower rise up to December and thereafter a decline from January to February. Wells 11 and 17 show a comparatively lower rise and decline in Nitrate values. Altogether, nitrate values in excess of 10 mg/l were observed mainly during the period September to February for the wells in category 1.

The nitrate content of the two wells 1 and 4 in category 3 shows a sharp rise from November to December, and a sharp decline in February and March (figure 10). An altogether different trend was recorded for wells 5, 7, and 12.

For wells 15, 21 and 23 the increase in nitrate values after September indicates a high level of eutrophication caused by leaching of nitrogen from soil and fertilisers. However, the decline in nitrate values after May underlines the absence of a long-term build up at this stage. The trend in nitrate values of wells 1 and 4 is understandable because they are located within the residual landscape. In all instances, a rise in nitrate values is followed by a decline after December to January which due to a dilution effect.

Compared with the values given for the coastal sand aquifer at Kalpitiya by Kuruppuarachchi (1995), which states that most irrigation wells had nitrate concentrations in excess of the WHO guidelines of 11.3mgN/l throughout the year, the conditions in the Nilaveli-Kumpuruppidi aquifer could be considered as more benign at present.

5.2 Chloride content

Figure 11 shows the variation of the chloride content of the five agro-wells 11, 15, 17, 21 and 23. Figure 12 gives the data values for the wells 1, 4, 5, 7 and 12. All wells in category 1 have a chloride content of less than 100mg/l as seen in figure 11. A significant variation in chloride is only observed for wells 15 and 23. They show an increase from October to November, and a decline thereafter.

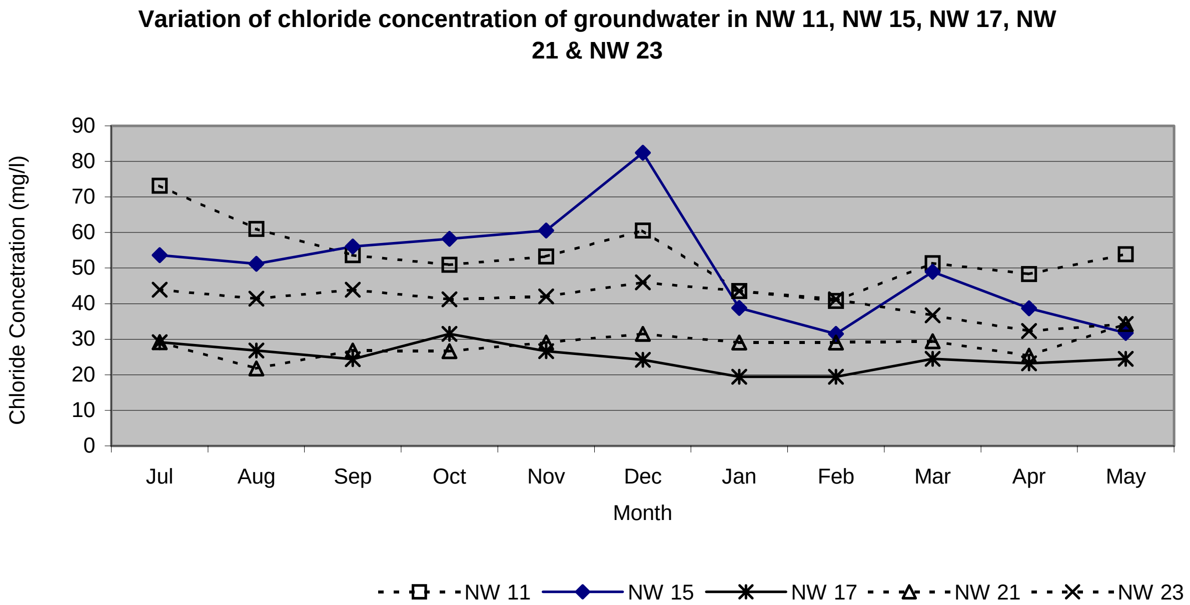

Figure 11: Variation of chloride concentration in NW 11, 15, 17, 21, 23

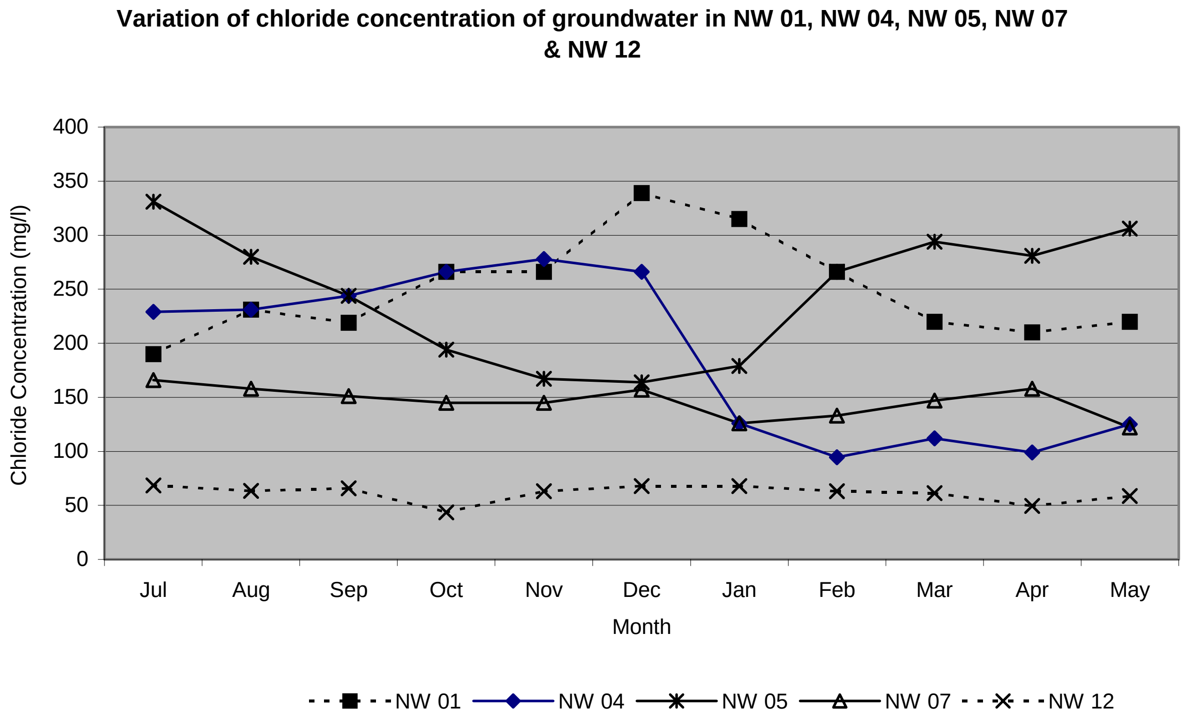

Figure 12: Variation of chloride concentration in NW 01, 04, 05, 07 & 12

Wells in category 3 have an initial chloride content of more than 100mg/l except for well 12. Here too, a rise in values between October and December is followed by a decline from January to February. It should be noted that wells 1, 4, and 5, all of which have high chloride values, are located on the residual landscape which is subject to less leaching than recorded for the Regosol landscape. In all instances there is significant leaching and dilution of the chloride content of well waters after the heavy November to December rains.

It is hypothesised that the higher Maha season rainfall in the Nilaveli-Kumpuruppidi aquifer area is sufficient to leach out any chlorides that accumulate during the dry season. This is in contrast to the Kalpitiya aquifer which receives a lower Maha rainfall and is also exposed to the sea spray from both sides of the peninsula. Values quoted by Kuruppuarachchi (1995) for the Kalpitiya Regosols state that chloride concentrations in agricultural wells were typically in the range of 100 to 300mg/l.

5.3 Estimation of pesticide residues

Sampling of water from agro-wells for the estimation of pesticide residues was carried out on 17 August 2001 at seven locations by employing the field method stipulated by the Industrial Technology Institute, ITI (formerly CISIR). 10 ml of chloroform was added to the sampled water as a preservative at sampling time. Testing was done at the ITI laboratory employing the Gas Chromatography method from 25 August 2001 onwards, and results were received on 7 October. The test report results carries the number SS 36103.

As could be seen, no pesticide residues of any kind tested for, were detected in the sampled waters. This is not surprising, considering the fact that none of the listed pesticides or their derivatives are presently used by the farmers. Pesticides such as Carbofuran (methyl carbamate) which were earlier used at Kalpitiya and were reported to have been leached in to the water table are now not in use. Nor are the previous hydrocarbon and organophospherus pesticides presently used in onion cultivation. What is now being used are mainly the synthetic Pyrethroid pesticides that are rapidly degradable in the soil and therefore do not cause any chemical pollution of the groundwater.

The good news, therefore, is that there is no risk at present posed by the present use of the type of pesticides that farmers resort to for pest and disease control purposes. However, the application of pesticides needs to be monitored on a broader scale to obtain more reliable results over time.

6. Phase II of agro-well monitoring

Phase II of the survey on water quality and quantity commenced in August 2001 with the selection of 40 monitoring wells. The wells are made up of 34 wells from the Nilaveli-Kumpuruppidi aquifer and 6 wells from the Kuchchaveli aquifer. The location of these 40 wells is given in maps 2 and 3 respectively. Of the 34 wells in the N-K aquifer, 18 wells are a carry over of the same number of wells that were studied in phase I, and would thus provide an essential continuity from the first phase of the survey. The other 16 wells are entirely new locations. They were selected from the preliminary Nitrate content survey carried out from May to June 2001.

The six wells selected from the Kuchchaveli aquifer represent the dominant land use types in this area as well as the respective landform position. Three of the agro-wells are located north of Kuchchaveli town, and three are located south of Kuchchaveli. All are representing the Regosol landscape.

Preliminary monitoring results for the months of August and September 2001 already show the enrichment areas for nitrate and potassium. Both these areas record conductivity values in excess of 1,000umhos/cm. In the Kuchchaveli aquifer, Phosphate enrichment is indicated within the township mosque and school areas respectively.

7. Findings and recommendations

A twelve-month period of monitoring of 24 agro-wells from July 2000 to July 2001 located within the Nilaveli-Kumpuruppidi coastal sand aquifer has shown that in terms of the EC value of the groundwater, three categories of aquifer domains could be recognised:

- Category 1 which covers around 65 percent of the area shows a conductivity value between 400 and 1,000 mhos/cm
- Category 2 which covers around 25 percent of the area shows conductivity values between 900 and 1,300 mhos/cm
- Category 3 which covers around 10 percent of the area shows conductivity value of between 1,000 and 2,000 mhos/cm.

For all three categories of aquifer domains, a rise in EC values takes place following the main Maha season rains in November. The rise is related to the leaching or washing down of soil solutes that have accumulated in the soil during the preceding dry season, and also the concentration of solutes from the lifted groundwater caused by dry season lift irrigation. The initial rise in EC values is followed by a period of stability from February to March, especially in category 1, and to a lesser degree in categories 2 and 3. This phase is then followed by the April rains where a sharp decline in EC values takes place in all three categories of aquifer domains. In the fourth phase a steady rise in EC values takes place up to June in all three domains after which a natural equilibrium status is reached at the threshold levels of EC.

The three domains of aquifer quality are in conformity with the three main geo-morphological sub-regions recognised in this N-K aquifer region as a whole. The seasonal pattern of EC variation is of a cyclic nature with differences in its pattern between the three different domains. The cycle of washing out, concentration and subsequent dilution of solutes is common to all domains.

In summary, it is concluded that at present there is no direct or indirect evidence of a build up or concentration of solutes in these aquifer domains. It is hypothesised that there is sufficient quantity of Maha rainfall (around 800 mm) that enables a leaching out and dilution of solutes that build up during the dry Yala season. However, the existence of any micro-domains of long term solute concentration in the aquifer could be examined in more detail in phase II of the survey.

It could also be stated that the agro-well system in domain category 1 reveals to a certain extent a high level of robustness and resilience in terms of its solute dynamics. This is followed by domain category 2 which is less stable and poised, and should be therefore carefully monitored in future. However, in respect of a possible nitrate build up even category 1 domain has to be studied further.

The monitoring of the nitrate content of 10 agro-wells shows a sharp rise in the initial values in September followed by a decline in values after January to February. A high level of eutrophication is observed for well numbers 15, 21 and 23 caused by leaching of fertiliser. However, no long term build-up is indicated. Compared with values reported for the coastal sand aquifer in Kalpitiya, the condition in the Nilaveli-Kumburuppidi aquifer could be considered as more benign.

The monitoring of the chloride content of the same ten wells show a significant leaching and dilution of chloride of the water after the heavy November to December rains. Here again, compared with the values reported for the Kalpitiya aquifer, the chloride status of water in the N-K aquifer is considered to be well within the safe limits of the average chloride content. Recognising the higher rainfall received in the Nilaveli area as compared with the Kalpitiya area, and also the more robust and hydrologically better endowed nature of the aquifer in the Nilaveli – Kumpuruppidi area, it is reasonable to assume a more robust condition in this aquifer.

It should also be noted that the irrigation practices and irrigation intervals adopted in the Kalpitiya peninsular are quite different to the practices in the Nilaveli area. This is mainly due to the better body in the Nilaveli Regosols which have a minimum clay content in their natural state.

It could be questioned whether any further improvement or refinement of the present irrigation and on-farm methods practised by farmers is possible in the Nilaveli area. This should be explored further by some kind of action research in the field. However,
one distinct area where considerable improvement is possible, and where farmers are already active is the cultivation of a green manure crop sun-hemp (crotolaria juncea) in late October and ploughing it back to the soil in December. This very essential practice would ensure the sustainability of high yields by building up the threshold level of organic matter in the soil.

References

Lawrence A.R., Kuruppuarachchi D.S.P, and Fernando N. (1989). A Report on Progress of Investigations at Kalpitiya. Tech. Report WD/89/59R. British Geological Survey and Water Resources Board Sri Lanka.

Kuruppuarachchi D.S.P. (1995) Impact of Irrigated Agriculture on Groundwater Resources of Sri Lanka, Sri Lanka Ass. Advmt. Sec. Proc. Part II.

Groundwater studies on the coastal sand aquifers of Sri Lanka

Distribution Pattern, General Characteristics and Present Utilisation Types:

- Map of scale 1:1,000,000 showing the broad distribution patterns, and explanation of different types.
- Geomorphic setting of the different types of coastal sand aquifers, and their main characteristics.
- Past and present manner of utilisation – land utilisation types – e.g. Fisherman village settlements, coconut plantations, intensive agro-well farming, tourist hotels and nature reserves.

Nature of studies/investigations carried out at different periods

Studies carried out by Geological Survey Department from 1945 – 1965 for small town water supply.

Investigations conducted by Irrigation Department. Groundwater Unit from 1965 – 1975 and with Israel assistance.

Investigations carried out by Water Resources Board from 1975 sometimes with foreign assistance.

Investigations for groundwater conducted by Water Resources Board for IRDP, commercial and state organisations – Past 1978.

Accelerated tube well water supply to rural areas with some supporting investigation by the Water Supply and Drainage Board NWSDB – past 1978.

Percentage of published studies on coastal sand aquifers relative to other aquifer studies – <u>See annex 1</u> of list of relevant studies pertaining to coastal sand aquifers.

Examples of published studies/investigation on some coastal aquifers

Kalpitiya Aquifer – WRB, DOA and ODA 1987 – 1991.

Nilaveli Aquifer – WRB with GTZ support – 1999 to present

Katunayake Free Trade Zone – WRB 1980 onwards.

Koggala – BOI – 1990 onwards.

Review of past studies – gaps in knowledge and future directions

Areas covered by past studies, and areas yet to be studied.

Scope of past studies and their limitations.

Gaps in past studies.

Proposed future studies and directions.

Ground water studies on the coastal sand aquifers of Sri Lanka
(C.R. Panabokke)

Distribution pattern, general characteristics and present utilisation types

The distribution patterns of the Coastal Sand Aquifers could be very reliably demarcated on the accompanying Map 1 of scale 1:1,000,000 because all these types of coastal sand aquifers are co-terminus with the map unit Sandy Regosols, as well as the map unit Latosols and Regosols on old red and yellow sands of the 1:500,000 scale of the 1981 Soil Map of Sri Lanka. Hence this demarcation of the Coastal Sand Aquifers on this 1:1,000,000 scale annexed map could be considered as an accurate demarcation of their occurrence and distribution patterns.

According to our present knowledge and understanding, three main types of coastal sand aquifers have been recognised and characterised in Sri Lanka:

- Shallow Aquifers on Coastal Spit – a deposit of unconsolidated material or a narrow shoal projecting with the sea from the shore and e.g. Kalpitiya, Pooneryn, Mannar Island.

- Shallow Aquifers on coastal sands/raised beach – a beach/low sand dunes with an elevation above the reach of waves of present times.

- Moderately deep aquifers on old red and yellow sands of prior beach plains.

The aquifers of type 1 occur exclusively within the dry zone, while type 2 occurs more extensively along the coast line of both the dry and wet zone as well as the intermediate zone; and type 3 occurs mainly within the old coastal plain of the north west depositional plain situated in both the intermediate and dry zones.

The total extent of aquifers of type 1 and type 2 is estimated at around 140,000 ha and type 3 at around 40,000 ha (Somasiri, 2001). Although this is not a very big extent for this island nation, it constitutes a limited but a very precious resource of a highly renewable groundwater supply that supports both intensive human settlement and high value intensive agriculture.

In the dry zone, the aquifers are recharged mainly during the three to four months of rain during the Maha season, while in the wet and intermediate zones these aquifers are recharged throughout most of the year except during February to March. The aquifers could therefore be considered as very productive or as hydrologically well endowed resource.

As seen in the, the type 1 aquifer is mainly confined to the coastal spits characteristics of the Kalpitiya peninsula and Pooneryn peninsular; and it is also present over the Mannar island which is a growing coastal sand barrier bar. Type 2 is mainly confined to the numerous narrow strips of raised beaches and low sand dunes that skirt the coast line of the country wherever a bit of headland permits the build up and protection of these narrow coastal sand formations from wave action.