PROCEEDINGS OF THE SENIOR STAKEHOLDERS' MEETING ON GROUNDWATER IN THE JAFFNA PENINSULA

Jaffna, 16 May 2013

IWMI
International
Water Management
Institute

Front cover photos: *Top photo* - A farmer is watering his tobacco field with water from a well.
Bottom Photo - An onion field. Both fields are in Jaffna.
Photo credit: Sutharsiny Arasalingam.

PROCEEDINGS OF THE SENIOR STAKEHOLDERS' MEETING ON GROUNDWATER IN THE JAFFNA PENINSULA HELD IN JAFFNA, 16 MAY 2013

ORGANIZED BY IWMI

INTERNATIONAL WATER MANAGEMENT INSTITUTE

International Water Management Institute (IWMI). 2013. ***Proceedings of the Senior Stakeholders' Meeting on Groundwater in the Jaffna Peninsula, Jaffna, Sri Lanka, 16 May 2013***. Colombo, Sri Lanka: International Water Management Institute (IWMI). 34p. doi: 10.5337/2015.004

groundwater extraction / aquifers / water quality / water resources / water use / water supply / stakeholders / pollution / infrastructure / rain / Sri Lanka

978-92-9090-825-8

Contents

Objectives

Jaffna Peninsula is the northernmost tip of Sri Lanka and falls within the island's dry zone. Comprising 1,030 km² including inland waters, Jaffna gets very little annual rainfall compared to other parts of the country. Its residents, therefore, depend mainly on groundwater for survival. Nevertheless, it is one of the most productive agricultural areas of the country. Its groundwater is stored in the subterranean layer of limestone. The shallow groundwater found within karstic cavities originates from infiltration of rainwater. Whilst it is much utilized, it gets replenished by annual rainfall of about 1,200 mm, particularly during the northeast monsoon from November to February.

Since the end of the civil war, which all but crippled the local economy, the area is now developing rapidly. Roads and other infrastructure are reconnecting the peninsula to the other areas of the country. Water supply, housing, schools, banks and other facilities are being built, replacing old dilapidated structures. Many new industries are blossoming out, such as hotels, large manufacturing and processing plants and cottage industries.

Although these developments are bringing new hope and new opportunities they strain local water resources. For instance, groundwater is being polluted by untreated waste and disposed of waste by industries and hotels. Overextraction of groundwater is encouraging intrusion of seawater creating problems of rising salinity. Levels of nitrates and other hazardous minerals are also of concern threatening human health and endangering fauna and flora. These contaminants could even have a negative effect on agricultural production by bringing about plant diseases and reducing yields.

The situation is serious, but far from hopeless. Sound and sustainable groundwater management could guarantee supplies for generations. But key stakeholders need to act now. There is a real need for more sustainable utilization of groundwater in the Jaffna Peninsula, guided by suitable regulations and operational plans based on the hydrogeological and geochemical situation. In order to fulfill these requirements it is necessary to establish a groundwater monitoring network, develop a groundwater model for the region, study the spatial variation of water quality of the area and prepare groundwater vulnerability maps and reports incorporating information on land use and land management practices.

To support this process the International Water Management Institute (IWMI) planned to conduct two meetings: one in Jaffna, held today, and the other in Colombo to be held next August. The objectives of the meetings are:

- To highlight the importance of current groundwater utilization trends and the related issue of pollution and the need to address such issues with firm evidence.
- To explore potential options for more sustainable use and management of groundwater in Jaffna with decision makers in all stakeholder sectors.

Summary

The political authorities of the region, as well as the stakeholders representing government institutions, the private sector, INGOs, NGOs and funding agencies all agreed that groundwater in the Jaffna Peninsula should be protected and preserved by implementing a sustainable management program.

All the presentations were based on recent research, and presenters were keen to share their findings, find solutions to problems and implement them in partnership with others to help resolve the problems of Jaffna's groundwater. The National Water Supply & Drainage Board (NWS&DB), WRB, IWMI and the University of Jaffna had all conducted extensive studies and their results were more or less similar. Some serious health problems were reported as a result of people consuming polluted groundwater; hence immediate remedial actions are required before this situation gets worse and becomes irreversible. Therefore, establishing governance for groundwater in the Jaffna Peninsula was facilitated by the local political authority as well as by all the stakeholders.

Pipe-borne water for the people in the Jaffna Peninsula is an urgent need. Implementing the North Central Canal Project, which will bring Mahaweli River water to Iranamadu tank to replace the piped water to Jaffna through the Jaffna Killinochchi Water Supply & Sanitation Project (JKWSSP) was heartening news for all participants. The assurance given in a message from the Secretary, Ministry of Irrigation & Water Resources Management that this will take place was a welcome response to long-standing questions about the project's progress. Expanding industries while preserving groundwater was stressed. The attention of the Central Environmental Authority (CEA) and other relevant organizations was earnestly requested in this regard.

With a view to achieving the final objective of establishing governance for groundwater, discussions involving all stakeholders were conducted on the following four topics:

- Agree upon rules for sustainable and equitable groundwater management.
- Mitigate pollution threats.
- Reduce demand on aquifers by making the most of other water sources.
- Inform, educate and collaborate.

Thus the outcome of the workshop can be said to fairly represent the opinions of all stakeholders. Both projects, DSWRPP and JKWSSP, have recognized the need for improved regulation and their findings, along with the facilitation of IWMI, will help ensure successful and sustainable groundwater governance. The active participation of local university students was welcomed by delegates as a promising sign. Their request for sustainable use of groundwater for their sake and for future generations touched the hearts of all and will hopefully strengthen efforts to preserve the Jaffna groundwater resources.

Outcome of the meeting

1. The water management committee already functioning under the Chair of the Government Agent (GA)/District Secretary (Jaffna) is to continue with frequent meetings with the addition of some other important stakeholders, facilitated by IWMI.
2. Further discuss the experiences of others managing scarce water resources in the global context, whilst recognizing the uniqueness of the Jaffna groundwater resource.
3. Agree upon rules for sustainable and equitable groundwater management to suit the current situation. Mitigate pollution threats.
4. Reduce demand on aquifers by making the most of other water sources such as rainwater, water reuse, plowing before rains, wastewater for irrigation, etc.
5. Inform, educate and collaborate with the public and all other stakeholders.
6. Encourage further research and continue to have meetings with all stakeholders to present research findings.

Agenda

09.00 am – 09.15 am	-	Registration
09.15 am – 09.30 am	-	Address by Dr. Peter McCornick, Deputy Director General, IWMI
09.30 am – 09.45 am	-	Address by Eng. G. Sarwanapawan, Senior Program Officer, Dam Safety & Water Resources Planning Project (DSWRPP) representing the Secretary, Ministry of Water Resources Management
09.45 am – 10.00 am	-	Address by Mr. G.A. Chandrasiri, Hon. Governor – Northern Province
10.00 am – 10.55 am	-	Presentations on the groundwater situation in Jaffna: Status and trends
		1. Eng. Duleep Gunawardena, Deputy General Manager – NWS&DB
		2. Mr. Ruwan Rajapakse, Senior Hydrogeologist – WRB
		3. Eng. N. Suthakaran,Deputy Director, Irrigation Department– Northern Provincial Council
		4. Mr. Croos, Consultant, JKWSSP
		5. Dr. Manthrithilake, Head, Sri Lanka Program, IWMI
		6. Mr. Thavendra Kumar, Regional Manager, NWS&DB
10.55 am – 11.10 am	-	Tea
11.10 am – 12.10 pm	-	Group discussions: The way forward
12.10 pm – 01.30 pm	-	Plenary session
01.30 pm – 01.40 pm	-	Summing up and vote of thanks
1. 40 pm	-	Lunch

1. Address by Dr. Peter McCornick, Deputy Director General, IWMI

Good morning! Hon. Governor, colleagues, and friends, welcome to this workshop on the groundwater resources of Jaffna. I am very pleased to be here today, and look forward to the presentations and discussions on how to better manage the critical groundwater resources in the region.

Before going to the content of the workshop let me introduce you to the International Water Management Institute (IWMI), which was originally the International Irrigation Management Institute (IIMI). IWMI is one of the 15 international agricultural research institutes of the Consultative Group on International Agricultural Research (CGIAR). IWMI is the only international organization headquartered in Sri Lanka, and our mission is to improve the management of water and land in developing countries. IIMI was established by a parliamentary act in 1985. Our headquarters are located at Pelawatta, Battaramulla.

We are affiliated with the Ministry of Irrigation & Water Resources Management in Colombo and also work with many other agencies in the country. Many of them are represented here today. We primarily work in Asia and Africa, with considerable experience in groundwater management, most notably in India, and more recently in South East Asia, sub-Saharan Africa and Central Asia.

IIMI was established in the middle of the Green Revolution when considerable investments had been made on irrigation infrastructure, but the overall performance was not as expected. IIMI was established with a mandate to examine irrigation management in an interdisciplinary way to consider the social and institutional dimension, and the governance of these systems, as well as infrastructural requirements. To this day, our staff includes those from different disciplines.

Today IWMI's mission is water for a food-secure world. How can water be managed to allow for agricultural production, environment requirements and other uses of water. The needs of the environment need to be carefully considered because reversing damage is often very difficult.

In the past we have worked in many of the larger river basins and irrigation systems in the country, and in the management of wetlands in the south of the country. Our current efforts include establishing a water portal web-based information system for Sri Lanka. We are also working on wastewater reuse and recycling, wastewater irrigation and business opportunities to convert sludge to fertilizer. More recently we have been working on climate change adaptation, and on groundwater management here in Jaffna, Kalpitiya and areas where small tanks are likely to be impacted by groundwater development.

This workshop includes work we have been doing here in Jaffna, and which Dr. Mantrithilake has been directing. Groundwater in Jaffna is limited, particularly fragile and precious; hence we need to consider how best this should be managed drawing on experiences from other countries as the recovery process would be difficult if it is damaged.

We look forward to continuing to work with the many partners represented here. Effective management of the groundwater resources requires the full engagement of the local partners.

Thank you.

2. Address by Eng. Sarawanapawan, Senior Program Officer - Dam Safety & Water Resources Planning Project (DSWRPP) representing the Secretary, Ministry of Irrigation & Water Resources Management

(Message from Eng. Ivan de Silva, Secretary to the Ministry of Irrigation & Water Management)

The Secretary to the Ministry of Irrigation & Water Resources Management was unable to attend the meeting due to unavoidable circumstances and Eng. G. Sarawanapawan, Senior Program Officer, DSWRPP delivered the message of the Secretary.

Thank you for giving me an opportunity to address this meeting. Hon. Governor, Deputy Director General of IWMI, Chief of Security and other distinguished guests, ladies and gentlemen. The Secretary of the Ministry of Irrigation & Water Management informed me of his inability to participate at the meeting and requested me to convey his message. The Ministry did not have an opportunity to support Jaffna Peninsula until 2011. However, the Ministry was fully aware that groundwater in Jaffna was not properly utilized due to overextraction without considering its recharge. As a result, water gets saline and contaminated. When it happens, reclamation and remedies are very difficult and the main issue is that it takes a longer period to recover. Therefore, our Ministry always wanted to support undertaking of groundwater investigation and prepare a proper groundwater extraction and monitoring plan to enable the people in Jaffna Peninsula to use this asset in a sustainable manner with the technical assistance from the Ministry. In 2011, the Ministry provided funds under the DSWRPP to carry out investigations in four Divisional Secretary areas. Since 2012, our Ministry has been continuously providing funds to study the rest of the areas in the peninsula. Therefore, funds are not a restriction to cover research works in the whole Jaffna Peninsula area. Monitoring programs for the entire Jaffna Peninsula are being done through the Water Resources Board and they had been involved in this work since 2011 doing very useful and productive work and we appreciate their efforts. Also all the politicians, Government and other officials and the people in the Jaffna Peninsula have supported conducting investigations and surveys. We appreciate all the help and assistance provided to us. We expect similar and more assistance in the future too.

Since IWMI too is willing to facilitate this work it is easy for the Ministry to carry out investigation work effectively because IWMI has much international experience in this field. Therefore, we will be able to make use of their expertise in a very effective manner.

The main uses of groundwater are for drinking, domestic and agricultural purposes. The Government and the Ministry are planning to provide pipe-borne water from the Iranamadu tank with the assistance of the Asian Development Bank (ADB). This work is in progress and already the investigation part is over and construction work will commence soon. But in the Iranamadu tank, the water capacity is limited and it may not be sufficient to provide water to all people in the Jaffna Peninsula. Therefore, the Ministry is planning to use the Mahaweli as a supplementary source to provide the Iranamadu tank with water. This is done through the North Central Province (NCP) canal. The proposal has already been finalized. This construction will be completed within 5 years.

With this message I conclude my speech thanking you again for giving me this opportunity to keep you informed of our work and plans.

3. Address by Mr. G.A. Chandrasiri, the Hon. Governor, Northern Province

Dr. Peter McCornick, Deputy Director General, International Water Management Institute, Representative of Eng. Ivan de Silva, Secretary to the Ministry of Irrigation & Water Resources Management, Representative of Mr. Abeyagunasekara, Secretary to the Ministry of Water Supply & Drainage, Mrs. R. Wijialudchumi, Secretary of the Northern Provincial Council, my secretary Mr. Ilangovan, all the senior officials from the Northern Province Council, Division Secretaries, officials from the Chamber of Commerce and other senior officials from the government organizations, international and local nongovernmental organizations, senior academics from the universities, all other honored guests and invitees present here--Good morning to every one of you. First, I must tell you I was listening to the two previous speeches, the first speaker explaining the objectives of the meeting and the second speaker explaining the future development proposals for the Jaffna Peninsula. I would like to give from my understanding some practical experiences about water management done during the last three and a half years as the Governor in the Northern Province. When I went through the particular report (IWMI research) I found the present status of groundwater in the Jaffna Peninsula was very undesirable. If we consider the entire Northern Province the situation in the Jaffna Peninsula may not be that bad.

I could remember those days, about three and a half to four years ago when all the people had only one location in Cheddikulam for their water supply. We had a system of water management to get the requirements of the people in those areas in a proper manner. The gentlemen who worked in that area at that time are here today. Now the Government has started the Iranamadu project and our engineer gentleman says that although the Iranamadu project will be completed within the next 5 years, water may not be enough for future requirements of the Northern Province. But for that there is a solution announced by the gentleman representing the Secretary, Irrigation & Water Resources Management. Diversion from Mahaweli will take place and the Iranamadu tank will get water towards the end of the next 5 years. That is the plan worked out by the Government to give more water to the Northern Province up to Kayts.

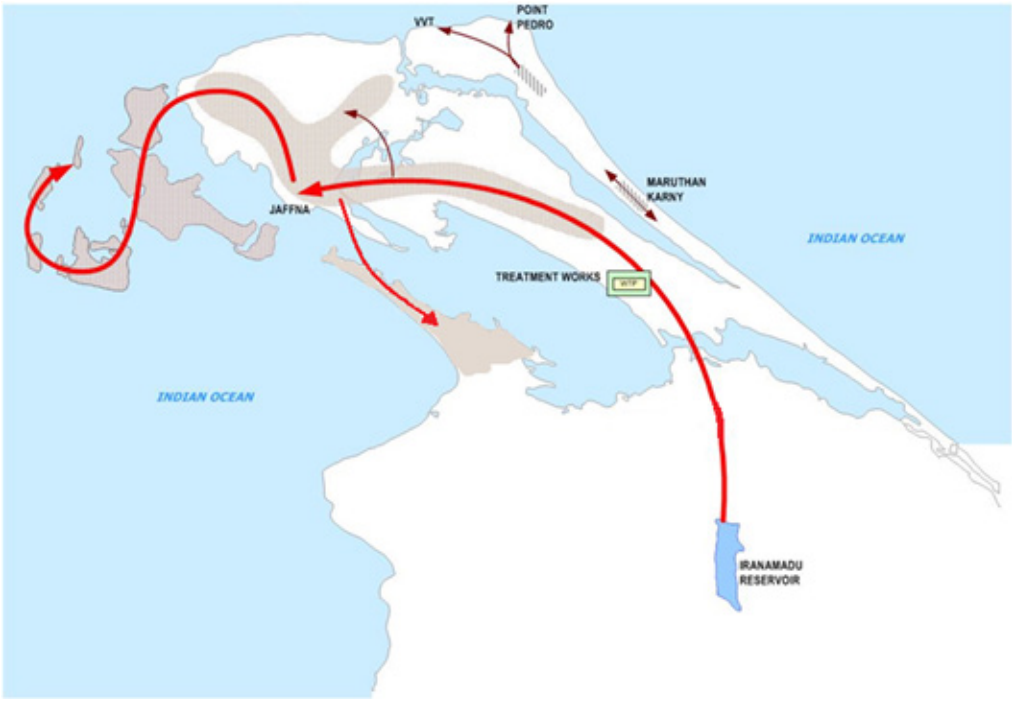
When it comes to the Jaffna Peninsula, our gentlemen told us not only the concept that should be adopted on basic principles but also what the areas they are looking at are. So I hope at today's meeting the gentlemen who have a better knowledge about the subject of managing groundwater will teach us to do it in future to make sure that we manage the water in the peninsula properly; how to make *kulams* (reservoirs) and tanks, and what other arrangements that should be made. I hope you all will discuss these areas properly as you all are better experts than me in this area, but one thing from my side I must tell you from the point of view of the provincial side of the Government; we will be supporting and assisting all of you whenever you come up with proper and viable solutions that can be projected to the Government and also to the required authority. Our Ministry is represented here. So I think they will work out a plan and will implement it properly. My point of view is that's all I would like to say at this stage; I also wish to listen to one or two presentations here and get more knowledge on how we can do water management properly. So I wish every one of you all the very best at the seminar today.

Thank you.

4. Presentations

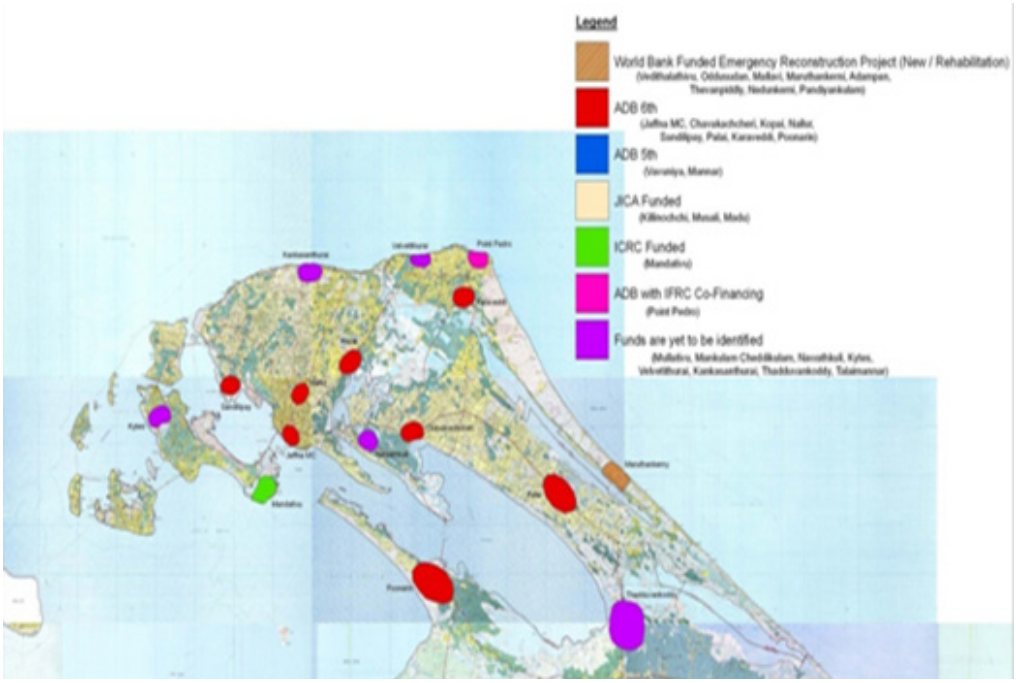
4.1 The first presentation was made by Eng. Duleep Gunawardena, Deputy General Manager, Northern Province, NWS&DB on *Current status and future plans for Jaffna water supply* (Figures 1, 2 and 3 and Table 1).

FIGURE1. Jaffna-Killinochchi water supply project.



Note: Not to scale.

FIGURE 2. Northern area map – Proposed schemes.



Note: Not to scale.

There are no problems, only solutions

Solutions

1. a. Quality improvement - Better quality water has reduced hardness (Calcium content) and conductivity (salinity).

   b. Quantity enhancement.

2. Demand management
3. Low flush/no flush toilet, efficient taps and showers and use of gray water.
4. Efficient water transport - Use of shorter pipelines/bowser runs, barges, trains.

Eng. Gunawardena stressed on the use of low-cost simple solutions for achieving the above. Also he explained that the availability of clean water could be increased by storing water in tanks, etc. Alternative uses such as rainwater harvesting and special arrangements to reduce water uses were explained with pictures which were very effective. He used pictures drawn by Indian children stressing the necessity to "safeguard, preserve and secure the uniqueness of Jaffna water supply. Future challenges: From potable to healthy water."

FIGURE 3. Jaffna Peninsula water quality 1965-1968.

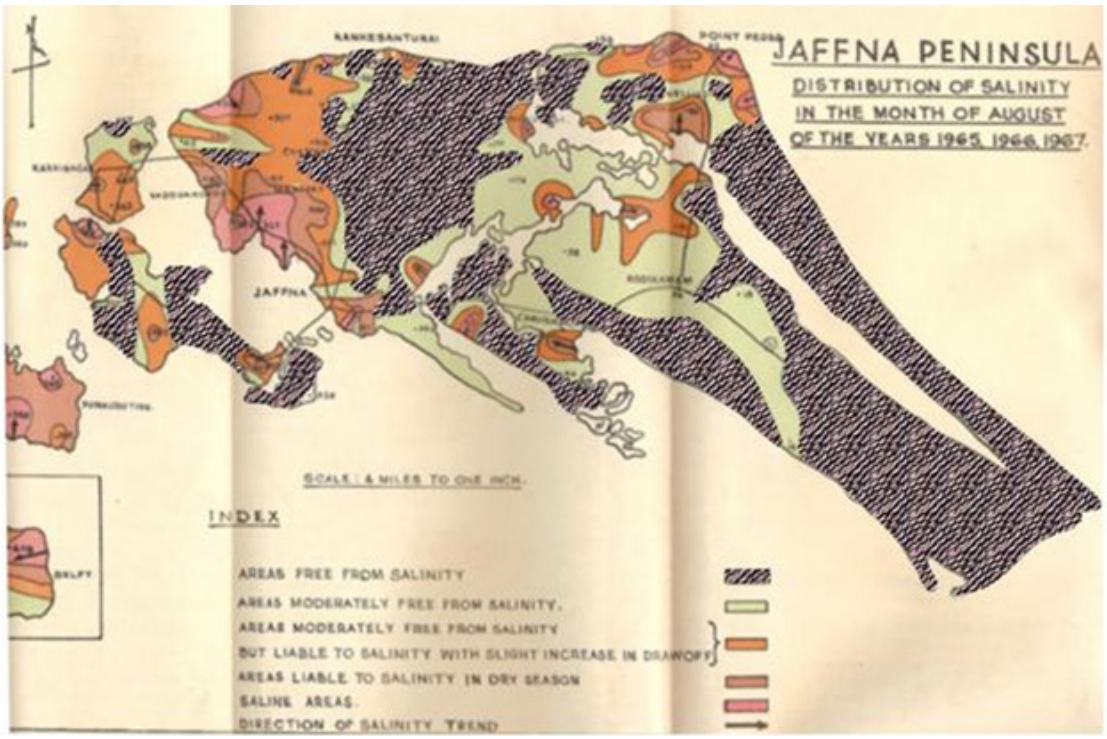


TABLE 1. Present water quality improvements and what is planned for tomorrow.

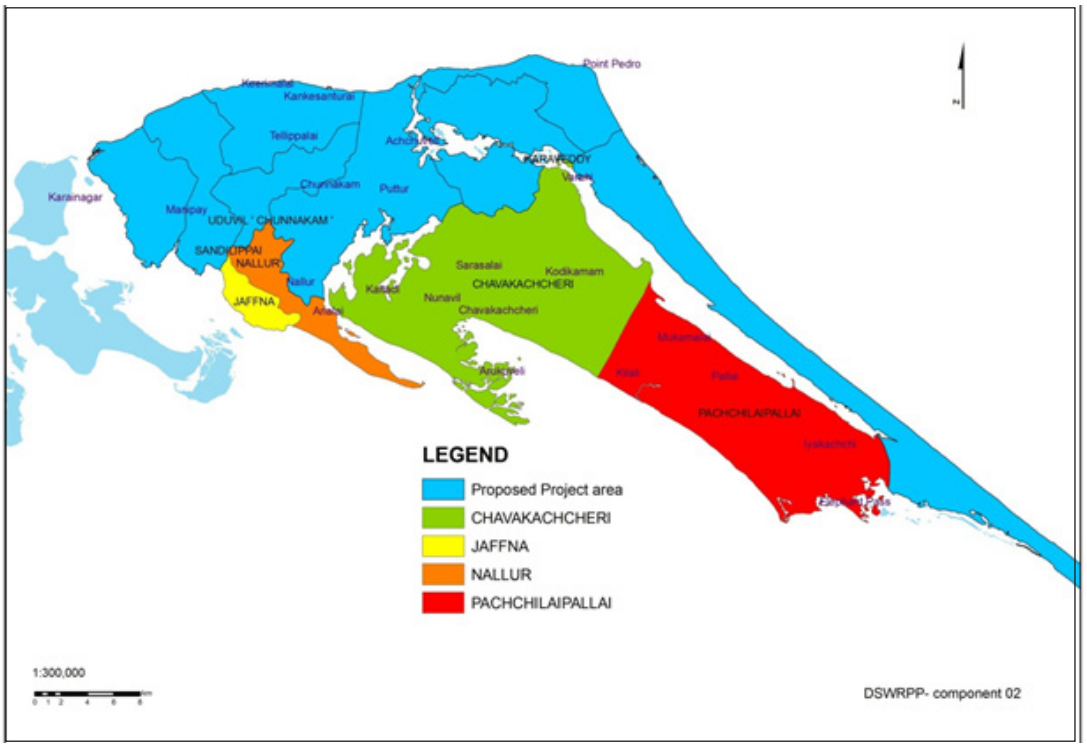
Aspect		City: today	City: tomorrow
Urban Water Management Organization	Organizational structure	Separate entities for different types of water	One entity for water covering the entire urban area
		Covering the entire urban area	City subdivided into water management units (WMU) with a high level of responsibility
			Water is a tradable good between units
	Units	Depending on preference of water entities	Determined by possibilities to manage water within a unit
	Philosophy	No relationship between various types of water	Various types of water are parts of the same cycle and serve various purposes at different times
Drinking water	Quality	One quality for all uses	One quality for drinking water and one for other uses
	Distribution	Underground pipe systems, and vendors	
	Origin	From wherever available	From nearby
Wastewater	Quality	Any quality wastewater is accepted	Only clean wastewater is accepted Dischargers responsible for quality of wastewater submitted
	Collection	Collection from domestic and industrial origins to points of discharge/(central) and treatment	Collection of clean wastewater within the WMU to point of further processing
	Treatment	Predominantly of the activated sludge type	Further processing determined by the reuse recovery options and the specific use of the water within the WMU
	Discharge	Into the nearest surface water	Depending on possibilities within WMU, e.g., irrigation, groundwater recharge, surface water discharge
	Approach	Removal as quickly as possible so as not to cause flooding	Make best possible use of this resource
Rainwater	Processing	Removal into server	Collection and temporary storage, followed by some type of treatment
	Usage	None	Various options, e.g., street cleaning, green areas, groundwater recharge, or drinking/process of water

4.2 The second presentation was made by Mr. Ruwan Rajapakse, Senior Hydrogeologist, Water Resources Board on *Groundwater management studies in the Jaffna Peninsula* under the Dam Safety & Water Resources Planning Project (DSWRPP).

According to him, the *groundwater issues identified in the area* selected by the DSWRPP (Figure 4) are as follows:

- Bacteriological contamination
- Extensive agricultural pollution
- Intrusion of seawater

FIGURE 4. Identified area for DSWRP project.



Hydrogeologically induced diseases in Jaffna

- Methemoglobinemia (blue baby disorder), caused by excess nitrate in drinking water.
- Kidney stones (urinary calculi) caused by excess calcium compounds in drinking water.
- Stomach cancers (gastric cancers), caused by excess amounts of nitrate in drinking water.

Studies in progress

a. Establishment of a long-term groundwater monitoring network for systematic monitoring of groundwater qualitatively in a pilot area in Jaffna under the DSWRPP (Figure 5; Table 2) with the following objectives:

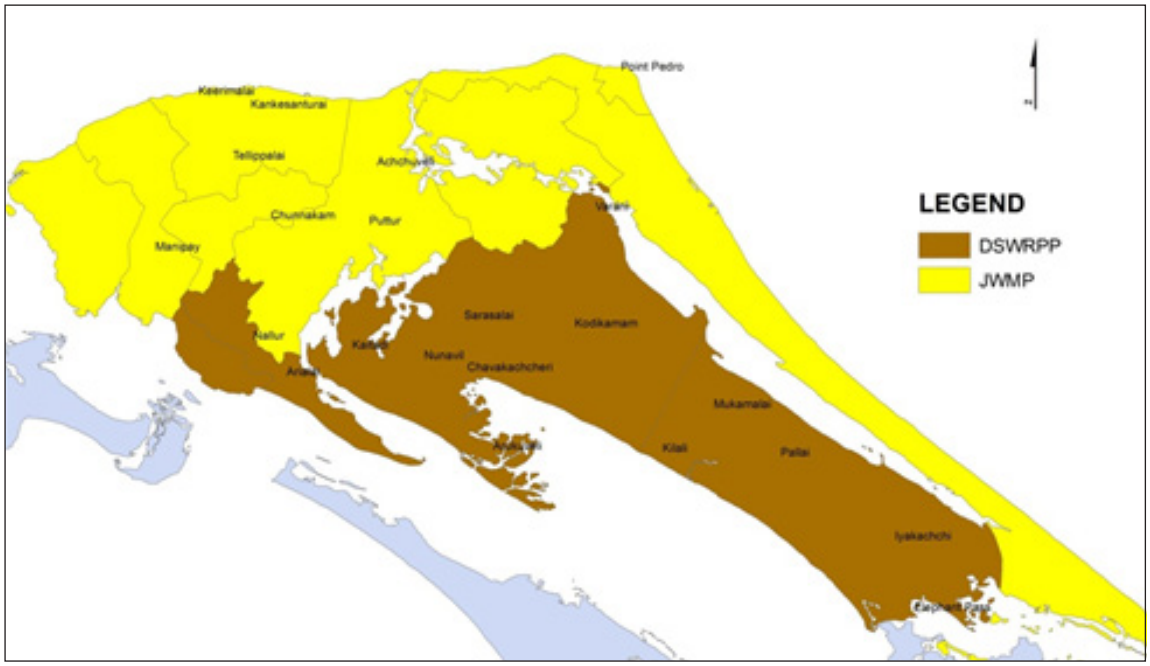
   - Determination of *hydrogeological and geochemical status* of the aquifers.
   - Assessment of hydrogeochemical evolution of groundwater in limestone aquifers.
   - Knowledge dissemination on groundwater potential, trends vulnerability and issues (among water users and authorities to be aware of the need for sustainable management and development of the groundwater resources) in the peninsula.

b. Groundwater assessment and development of a groundwater monitoring network for the Jaffna Peninsula (JWMP) (Figure 5) with the following objectives:

   - Groundwater quality assessment study.
   - Establishment of a groundwater *monitoring network.*

- Development of a groundwater database for the region.
- Preparation of groundwater vulnerability maps.
- Development of a groundwater model.
- In addition, several awareness-raising programs and workshops were held before and during the studies.

FIGURE 5. Study area.



Note: Not to scale.

TABLE 2. Output of studies.

Pilot area	Identified issue	Zone (area)	Reason/Remark
Jaffna	NO_3 pollution	Kopai, Kaithadi Thirunalveli, Nallur	Excessive agricultural practices; occur mainly in highly cultivated areas of red earth
	No bacteriological contamination identified	Jaffna, Nallur	Incidents reported earlier; this study reveals no such issue in large (regional) scale; the possibility of point source contamination due to poor sanitation
	High salinity	Ariyalai	Geophysics and hydrogeochemical data imply the possibility is due to intrusion of seawater
	Fresh groundwater zones	Iyakkathchi, Kadeikadu	Associated with isolated sand lenses with low electrical conductivity (EC)

Proposed future studies

- Comprehensive hydrogeological assessment of groundwater with low EC in the eastern coastal sand belt.
- Detailed hydrogeological and geophysical surveys in the northern coastal area covering Keeramalai springs.
- Continuation of groundwater monitoring and expanding the required areas under DSWRPP.
- Hydrogeological assessment of the Iyakachchi area.
- Groundwater study at Kayts and other islets.

4.3 The third presentation, *Groundwater resources development in Jaffna District,* was made by Eng. N. Suthakaran, Deputy Director, Irrigation Department, Northern Province.

Background

Due to the topography (flatness) and geology, there are no streams and rivers in the Jaffna Peninsula with the following characteristics:

- Groundwater storage is the potential for water resources development.
- Miocene limestone is the prime source of water storage.
- Porous characteristics such as fissures, cracks and joints permit percolation of freshwater to be stored underground.
- Recharge to the groundwater is almost entirely from percolation of rainwater.

Present status of groundwater

Groundwater is badly polluted, mainly due to the following:

1. Heavy agricultural practices (excess amounts of Nitrogen) mainly in shallow aquifer groundwater.
2. Overextraction of groundwater, intrusion of salt water, and mainly, overextraction from sand dunes.
3. Destruction of existing schemes and barrages or no control mechanism resulting in freshwater sources becoming brackish and a considerable fertile land area getting contaminated.

Potential groundwater sources

1. Valukkai aru drainage scheme, ponds/and ditches
2. Vadamaradchi lagoon scheme
3. Elephant Pass lagoon scheme
4. Upparu lagoon scheme
5. Thirty-four salt water exclusion (SWE) schemes

Groundwater Improvement Activities

1. Valukkai aru drainage scheme – at a cost of Rs 230 million

- To drain off excess floodwater to the sea during the rainy season.
- To prevent intrusion of seawater.
- To protect and conserve the groundwater.

- To manage water resource for the entire Valukkai Aru.

2. Salt water exclusion schemes – at a cost of Rs 96 million

Thirty-four SWE schemes were identified and constructed benefiting the coastal community of the islets and to prevent ingression of seawater to the lagoon.

3. Ponds and ditches – at a cost of Rs 150 million

Sometime ago, there were more than 1,000 ponds and ditches in the Jaffna Peninsula out of which only 450 are available now. They were rehabilitated to preserve and conserve groundwater and to facilitate drainage, irrigation, and lift irrigation and for domestic use.

4. Vadamarachchi lagoon scheme – at a cost of Rs 75 million

- Starts near Pachchilaipallai and ends in the sea at Thondamanaru. Rehabilitation works substantially completed.
- Salinity gets reduced after separation from sea.
- Action is being taken to introduce aquaculture.

5. Upparu lagoon scheme – at a cost of Rs 112.5 million

- Starts near Kapoothu and ends in the sea at Ariyalai.
- Rehabilitation completed except for 13 flood-protection bunds. Salinity gets reduced after separation from the sea.
- Action is being taken to introduce aquaculture.

Proposed Future Activities

1. Revival of Elephant Pass Lagoon – at a cost of Rs 900 million (2013-2017).
    - Popularly known as "River for Jaffna" – The proposal is to convert freshwater to the Vadamarachchi and Upparu lagoons. The schemes related to these two lagoons are now rehabilitated and functional.
    - Restoration of the Elephant Pass Lagoon is vital for efficient functioning of the Jaffna Lagoon.

The proposal is to take water from the Elephant Pass Lagoon by a link canal to the Vadamarachchi Lagoon and augment the supply of internal lagoons. The eastern closure bund was breached during floods and the scheme is now abandoned due to civil disturbances. A full investigation would be carried out afresh and the scheme would be restored**.**

2. Rehabilitation of all eight SWE schemes – at a cost of Rs 60 million.
3. Flood protection bunds in Upparu and Vadamarachchi lagoon schemes – at a cost of Rs 100 million.
4. Rehabilitation of minor tanks – at a cost of Rs 100 million.

Monitoring Activities

Figures 6, 7, 8 and 9 below show the salinity measurements at various sites of the Vadamarachchi Lagoon.

FIGURE 6. Salinity measurement of Vadamarachchi Lagoon: Thondamanaru bridge site.

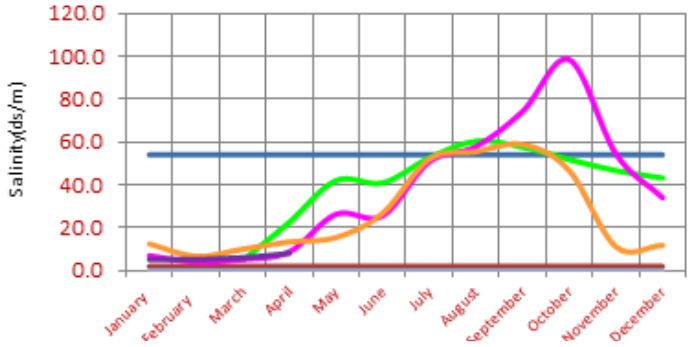


FIGURE 7. Salinity measurement of Vadamarachchi Lagoon: Vallai near bridge**.**

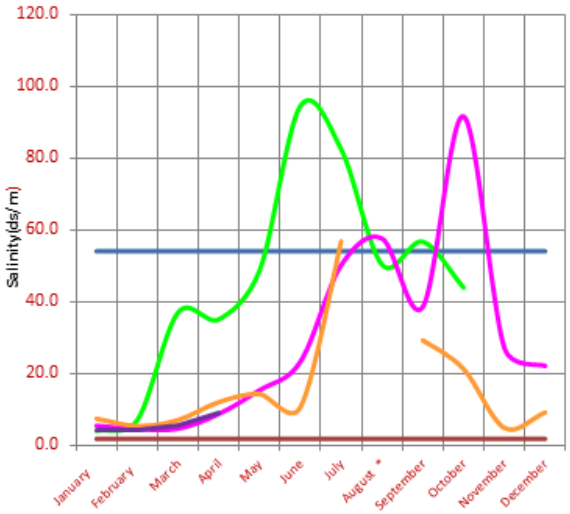


FIGURE 8. Salinity measurement of the Vadamarachchi Lagoon: Yakkarai Kanagampuliyadi Road, near bridge.

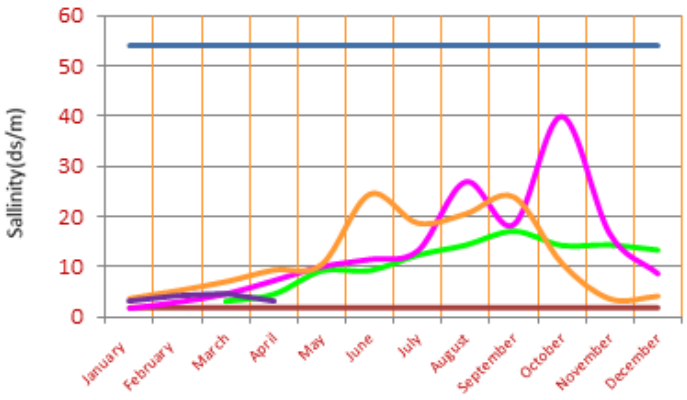
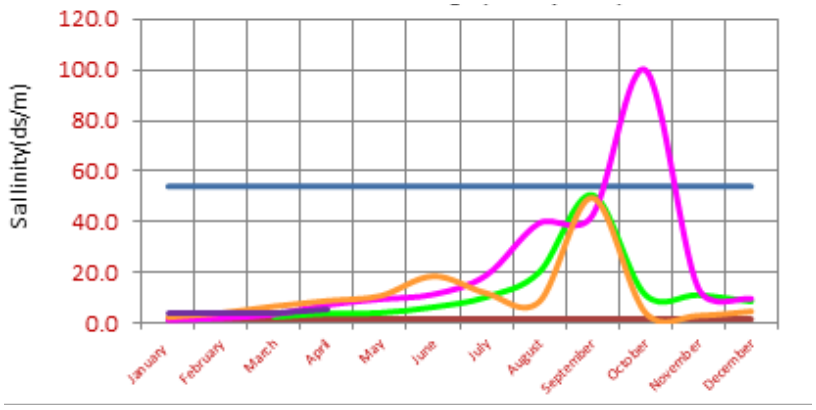


FIGURE 9. Salinity measurement of Vadamarachchi Lagoon: Mulli, near bridge (Varany Road).



Suggestions and Recommendations

1. Preserve existing sources (e.g., sand dune at Manakadu).
2. Limit agricultural practices during the dry season.
3. Introduce modern water saving techniques.
4. Introduce suitable crops through research.
5. Appoint empowered regulatory committees.
6. Create farmer awareness on motorized pumping.
7. Minimize the risk of overextraction and seawater intrusion.

4.4 The presentation on *Jaffna-Killinochchi water supply and sanitation project* (JKWSS) was made by Mr. Croos, Consultant to the project.

Components of the project

Component I.

- Water supply and sanitation infrastructure
  - Water supply
  - Sewerage and sanitation
- Improvement of Iranamadu tank headworks
- Management of Jaffna water resources
- Building implementation capacity

Loans - ADB - US$90 million; Agence Francais Developpment – US$48.00 million; Government of Sri Lanka - US$26.04 million; and International Fund for Agricultural Development - US$20.00 million.

Areas covered by the project

Jaffna · Kodikamam, Karaveddy, Chavakachcheri Navatkuli, Kopay, Atchuvely, Sandilipay, Kaddudai, Navaly, Chankanai, Nallur, Moolai, Araly, Vaddukkodai, Karainagar, Kayts, Analaithivu, Eluvaithivu, Punguduthivu, Velanai, Mandaithivu, Poonakery, Pallai. Water supply systems from groundwater sources and existing water supply schemes are shown in Tables 3 and 4, respectively.

TABLE 3. Water supply systems from groundwater sources.

Aquifer	Raw water available (m^3/day; average)	
	Dry period	Wet period
Kayts	215	360
Chunnakam	5,000	19,200
Point Pedro	2,100	3,700
Vadamarachchi East	2,400	5,100
Chavakachcheri	2,100	3,700
Pallai	1,500	2,900
Total	12,885	34,960

Water supply system from groundwater sources

- In the Jaffna Peninsula, currently 29 small-scale water supply schemes are functioning
- Time of supply -- less than 1½ hours.
- The total coverage of pipe-borne water supply through stand posts in the Jaffna Peninsula is about 3.2% compared to the country average of more than 37% due to weakness of the water resources.

TABLE 4. Existing water supply schemes.

Scheme	Operation and maintenance	Production m^3/d	Population served	No. of connections			Hours of supply
				HC	SP	Other	
Jaffna MC1	MC	900	35,000	377	600		3
Jaffna MC2	MC	210	7,000	52	75		2
Araly South	NWS&DB	22	4,430	26	10	9	1
Velanai	NWS&DB	43	3,040	1	37	15	1
Vaddukkoddai	NWS&DB	15	2,530	10	11	4	1
Chunnakam	NWS&DB	30	2,500	12	22	5	2
Watharawaththai	NWS&DB	80	2,080	34	46	11	4
Valvettithurai	NWS&DB	36	3,060	20	12	5	2
Kankesanthurai	NWS&DB	Abandoned					
Analaithivu	NWS&DB	2.6	220	1	1	4	1
Kayts	NWS&DB	117.0	5,040	17	61	12	1
Nainathivu	NWS&DB	8.0	630	1		8	1
Karaveddy	NWS&DB	200.0	10,840	353	83	7	2
Kanpolai	NWS&DB	3.0	600		1		2
Kaladdy	NWS&DB	Abandoned					
Karainagar	NWS&DB	30	900		9		2

Note: HC = Home connection; SP= Stand pipe

.

Component II - Establishment of a water resource committee

The above committee is to be established to address issues of environmental pollution related to agrochemicals, black water, solid waste disposal, garbage dumping, oil and overextraction.

High incidence of waterborne diseases in Jaffna District

Tables 5, 6 and 7 below show the incidence of waterborne diseases.

TABLE 5. Incidence of enteric fever.

Year	All-island	Jaffna	%
2006	1,892	159	8.4
2007	1,769	438	24.8
2008	1,908	261	13.7
2009	2,311	361	15.6

TABLE 6. Incidence of dysentery.

Year	All-island	Jaffna	%
2006	7,772	145	1.9
2007	7,197	155	2.2
2008	6,234	173	2.8
2009	7,365	139	1.9

TABLE 7. Incidence of Viral Hepatitis A.

Year	All-island	Jaffna	%
2006	2,723	77	2.8
2007	5,836	29	0.5
2008	1,898	43	2.3
2009	6,808	205	3.0

Causes of the above diseases

- Pollution of underground water.
- Inadequate access to safe latrines (70%).
- Inadequate access to safe drinking water.
- Poor hygienic practices related to drinking water.

Nitrate-Nitrogen-related health problems

Cancer – Carcinogen, blue babies, food poisoning, and suspicion of contamination with pesticides and weedicides

Table 8 shows the nitrate contamination in supply wells and table 9 shows common pollutants sources and extent of pollution.

TABLE 8. Nitrate contamination in supply wells.

Year	Thirunelveli - NO_3–N	Kondavil - NO_3–N	Source
1976	15	22	Dr. V. Navaratnarajah
1980	22	30	
1982	27	34	
2005	16	18	NWS&DB
2009	18	24	Ms. T. Migunthan, Jaffna University

TABLE 9. Common pollutant sources and extent of pollution.

	Pollutant	Sources of the pollutant	Measuring unit	Maximum concentration	Location of test sources	Permitted maximumWHO standard
1	Salinity	Seawater under aquifer	As Chlorides mg/liter	>2,000	Map	1,200 mg
2	Nitrites	Agrochemicals fertilizer, human waste	As NO_2 mg/liter	0.263 mg/liter	Kondavil	0.1 mg/liter
3	Nitrates	Agrochemicals fertilizer, human waste	As NO_3 mg/liter	149 mg/liter	Kondavil	45 mg/liter
4	Organic leachate (Ammonia)	Solid waste from urban areas	Ammonia mg/liter	0.36 mg/liter	Kondavil	0.06 mg/liter
5	Ca/Mg Carbonate causing hardness	Limestone		48%	Standby round	600 mg/liter
6	Iron	Top soils/ fertilizers	Total (Fe) mg/liter	mg/liter		240 mg/liter

Activities of the Jaffna Water Resources Management Committee (JWRMC)

- Preparing JWRMC's framework, institutional arrangements, planning and management systems, capacity building and technical and financial support requirements.
- Developing and establishing data systems on water, land use and biotic resources.
- Conducting training and institutionalizing the use of predictive groundwater and hydrological tools.
- Improving recharging systems (rehabilitation of salt water exclusion schemes and abandoned minor irrigation schemes).
- Controlling the extent of agriculture during dry seasons.
- Coordinating, monitoring and reporting on the quality and quantity of water.
- Introducing modern water saving technologies (micro-irrigation, drip irrigation, minimizing flood irrigation, promoting rainwater harvesting, etc.).
- Providing support to local authorities in the preparation of bylaws and implementing rules and regulations to control water abstraction from the Jaffna Peninsula.
- Forming and developing regulatory committees at the village level.

4.5 This presentation on *Groundwater in the Jaffna Peninsula* was made by Dr. Manthrithilake.

Some relevant studies on groundwater are given below:

1952: Specific yields of the limestone aquifer

Kayts	0.8 gallon per hour from a square foot
Chunnakam	8.0 gallons per hour from a square foot (Sirimanne 1952)

1955: Pumping test

The safe rate of pumping varies from 2,400 gallons per hour in the Thenmaradichy area to 20,000 gallons per hour in Thirunevelly and to 35,000 gallons per hour in the Puttur area (Sirimanne and Vaidya 1955).

1967-1969: Studies on groundwater balance - Overdrafting from the aquifer (Arumugam 1970).

1968: Agricultural wells: 30 -100 acres (75 wells/100 ha) and density of domestic wells: 152/100 acres (380 wells/100 ha) (Balendran et al. 1968).

1994: After losses by direct runoff (about 10-15 %) and by evaporation (about 40-48%), only 30-32% of the rainfall is left over for groundwater recharge (Navaratnarajah 1994).

2002: Gesellschaft für Internationale Zusammenarbeit (GIZ)-Jaffna Rehabilitation Project (JRP) - over 100,000 dug-wells in the peninsula of which 17,860 are agricultural wells and the remainder is used for domestic and home garden purposes (Kraft 2002).

2006: ADB feasibility study recommended groundwater extraction rates as follows: Valikamam, 14,400 m^3/d, Vadamarachchi, 6,000 m^3/d, and Point Pedro, 4,000 m^3/d.

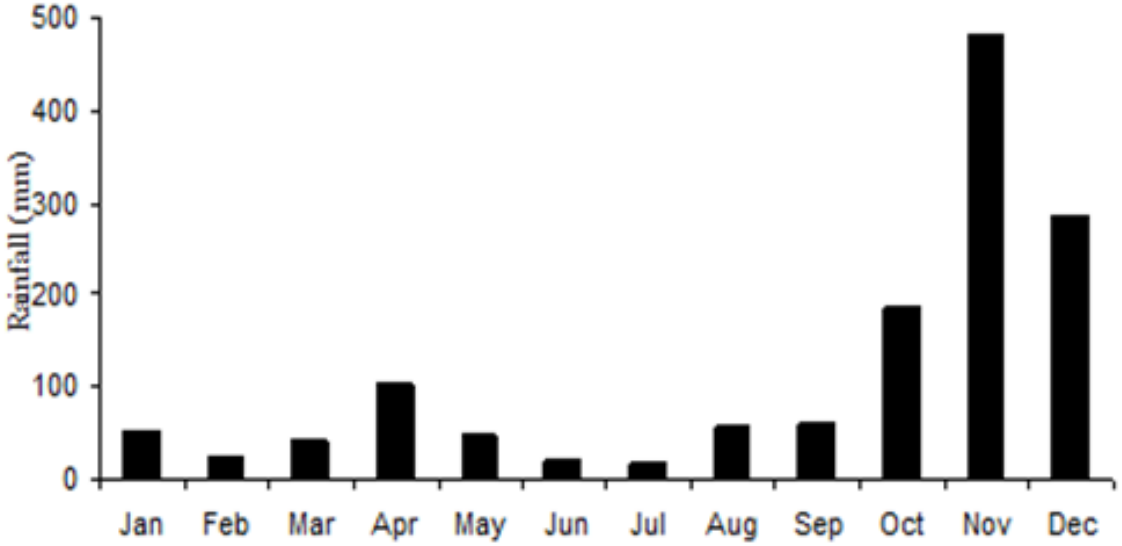
The most intensively exploited areas for urban water use are Jaffna, Chavakachcheri and Point Pedro, and to a lesser extent Valvettithurai.

The most heavily exploited areas for rural water use are Valikamam East and a small zone in Valikamam West (Feasibility Report 2006).

2011: Counting of agro-wells – number of identified agro-wells – 19,905 (excluding those in the Delft Island).

Figures 10 and 11 show the average monthly rainfall in Jaffna and annual rainfall trends in Nuwara Eliya, respectively.

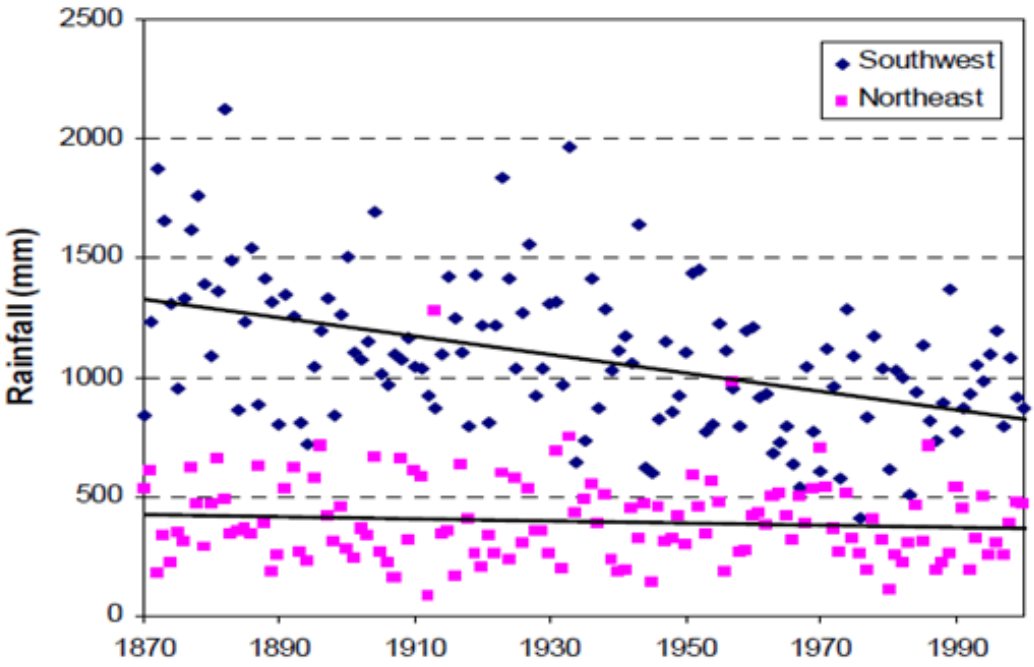
FIGURE 10. Average monthly rainfall in the Jaffna.



Source: 2002 to 2010: Jaffna District Statistical Hand Book 2011: Meteorological Station.

Threat 1. Rainfall Reduction

FIGURE 11. Annual rainfall trends in Nuwara Eliya.



The southwest monsoonal rainfall over Nuwara Eliya has reduced significantly (385 mm) over the last 100 years. Rainfall during the northeast monsoon has remained more or less constant (47 mm reduction over the last 100 years). Thus, the annual rainfall reduction is mainly caused by the southwest monsoons.

Threat 2. No. of agro-wells on the rise

Table 10 shows the density of agro-wells in the Jaffna Peninsula.

TABLE 10. Density of agro-wells in the Jaffna Peninsula.

	Valikamam		Medawachchiya		Kalpitiya	
	2003	2009	2004	2010	2001	2010
Land area (ha)	3,622	3,622	2,993	2,993	1,126	1,126
Agri. area (ha)	1,207	1,279 (+6%)	980	836 (-15%)	432	484 (+12%)
No. of wells	796	1,090 (+37%)	188	256 (+36%)	87	106 (+22%)
Density of wells	0.659	0.852	0.192	0.306	0.201	0.219

Threat 3. Overextraction from wells

Figures 12 and 13 show the overextraction from shallow wells and extraction from deep wells, respectively.

FIGURE 12. Overextraction from shallow wells.

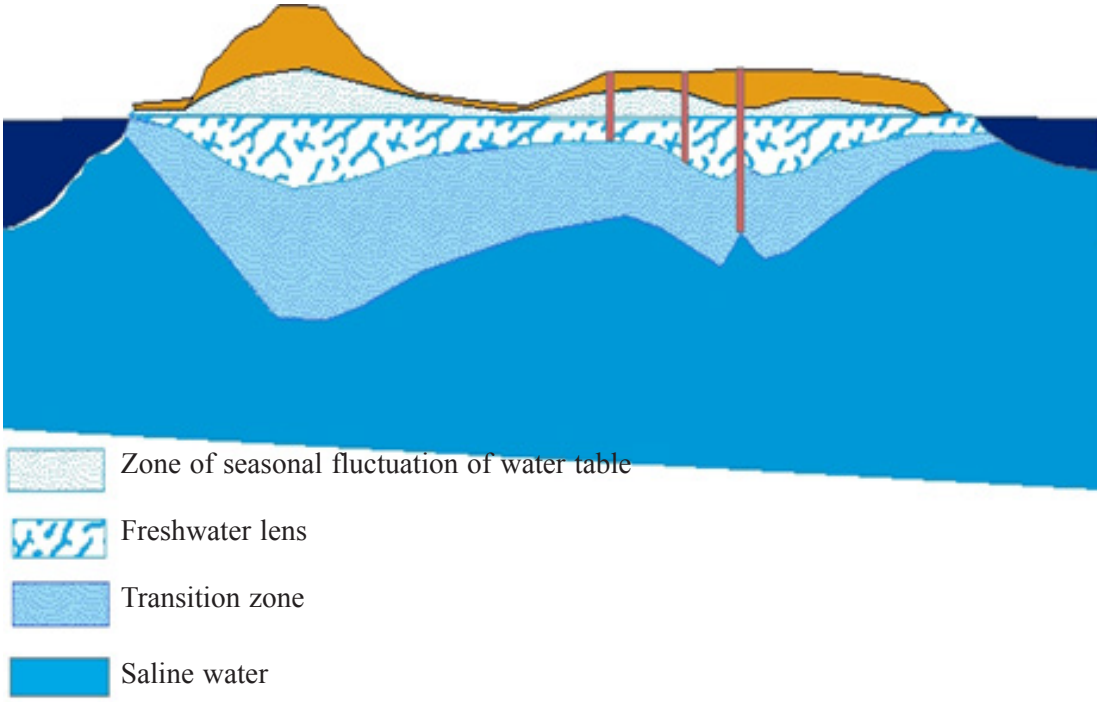
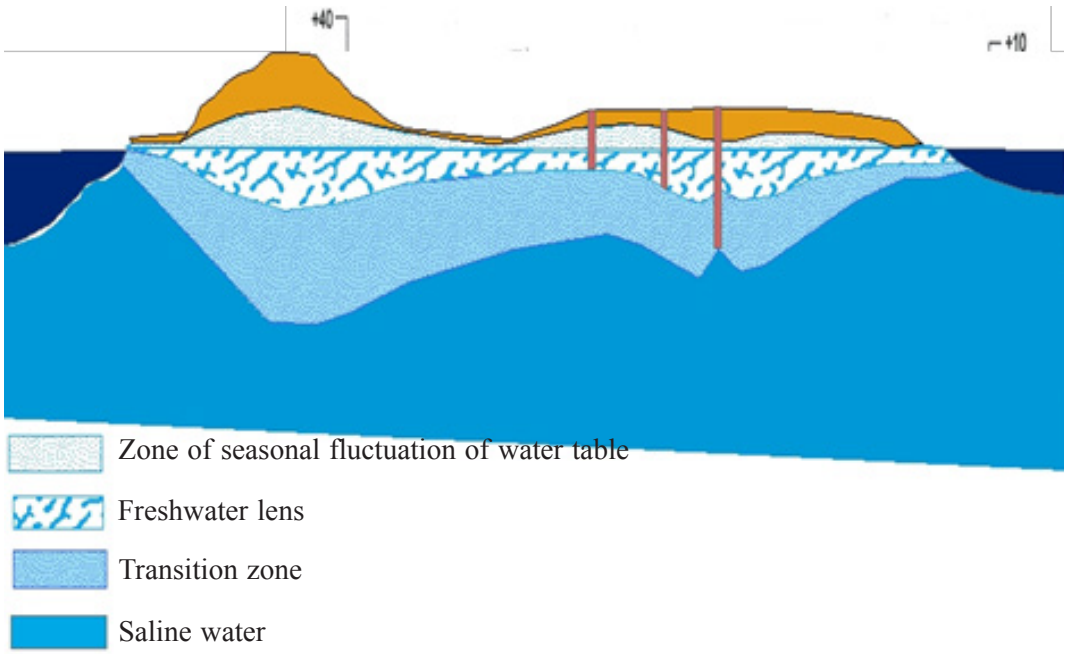


FIGURE 13. Extraction from deep wells.



Threat 4. Over-irrigation and excess application of nitrogen fertilizer.
Tables 11 and 12 show the over-irrigation of, and excess nitrogen application for, each crop in the studied area.

TABLE 11. Over-irrigation of each crop in the studied area.

Crop	Crop water requirement	Irrigation by farmers (mm/day)	Excess irrigation (mm/day)	(%)
Banana	4.98	11.86	6.88	138
Cabbage	4.76	15.65	10.89	229
Cassava	3.62	9.45	5.82	161
Onion	4.53	11.25	6.72	148
Tobacco	4.08	9.41	5.33	131

TABLE 12. Excess nitrogen application for each crop.

Crop	Average nitrogen applied (kg/ha)	Recommended nitrogen (kg/ha)	Excess nitrogen (kg/ha)
Onion	178.1	70	108.1
Carrot	230	150	80.0
Cabbage	142.6	150	-7.4
Beetroot	246	180	66.0
Tobacco	262.9	No recommendation	-

- Due to mixing up of abundant nitrogenous waste matter and fertilizers 80% of the wells were affected (Gunasekaram 1983).
- High level of Nitrate and Cl^- combined with low concentrations of Ammonia and Nitrite: Indicators for heavy groundwater pollution through organic or inorganic waste and wastewater (Kraft 2002).

Threat 5. Soil Type

- The major soils in the peninsula are calcic red-yellow latosols which are shallow, fine-textured and well-drained with a very rapid infiltration rate (50 m/day). (De Alwis and Panabokke 1972).

1. Water movement in the soil is often so rapid that filtration and removal of microorganisms within the unsaturated zone are not effective.
2. There is no purification capacity (500 m/day) on the limestone itself, which is widespread in the Jaffna Peninsula.

- Pollutants reaching the groundwater are therefore able to spread far and wide.

Table 13 shows the distance between pit latrines and dug-wells for two regions in the Jaffna Peninsula.

TABLE 13. Distance between pit latrines and dug-wells for two regions in the Jaffna Peninsula.

1990- Jaffna municipal area		1997- Valigamam area	
Distance (m)	% of dug-wells	Distance (m)	% of dug-wells
< 1.5	5.7	<10	13.6
1.6 – 3.0	8.0	10.1 -20.1	48.2
3.1 - 4.5	5.7	>20.1	38.2
4.6 – 6.0	6.8		
> 6.1	73.5		

Threat 6. Bacteriological Quality

- Normal coliforms showed that water from Passaiyoor, Kurunagar, Koddady and Navanthurai areas cannot be used for drinking or domestic purposes (Mageswaran 2003).
- Analysis of the tap water at Kayts, Gurunagar and the supply from the Kondavil well showed the water was contaminated with *fecal coliforms on E-Coli bacteria* (Kraft 2002).

Sources

- Latrines (type of pit constructed locally).
- Defecation on open areas and sludge disposal on land.
- Indiscriminate disposal of garbage and infective hospital waste.
- The open dumping yards for waste disposal - Kakaithivu: in low-lying areas.
    - Nayanmarkadu (Nallur): closed due to complaints from a neighbor
    - Muneeswaran Road: in low-lying areas, had filled up
    - Selvapuram: at the lagoon
    - Ceynor (Gurunagar): filled up (being used in 2001)

Figure 14 shows the present system of toilet pits.

FIGURE 14. Present system of toilet pits.

Threat 7. Impact on health - under threat... not only environment but human health too

By bacterial pollution

- Water and food-borne diseases: *Typhoid, cholera, infective hepatitis, diarrhea,* and *worm infestation*

By chemical pollution

- Work carried out in 1973 - 1977, Northern Province
  - had the highest incidence of cancer in Sri Lanka.
  - the incidence of esophageal cancer was doubled.
- WHO: More than 10 mg/L NO_3^{--} – N: "Blue babies"

  (No recorded cases as yet from the Teaching Hospital. A high risk of nitrate toxicity could lead to Blue babies.)
- Several studies have come up with warning on the risk of esophagus cancer and stomach cancer due to consumption of well water with higher nitrate - N concentration than the level recommended by WHO (Kraft 2002; Sivarajah 2003; Gunalan et al. 2011).
- Large amounts of calcium and phosphate in drinking water may accelerate stone formation in the bladder.
- High incidence of cancer (1973-77) could be partly attributed to the high nitrate content in water (Panabokke 1984).

Things to be done

- **To increase the groundwater recharge:**
  - ► Rehabilitation of existing tanks, recharge ponds.
  - ► Rainwater harvesting (roof water harvesting at schools, hospitals and public buildings).
  - ► Rehabilitation of the stormwater drainage system.
  - ► Installing meteorological stations.
  - ► Establishment of spatially distributed rainfall recording stations. (Rainfall is measured only at one station in the entire peninsula.)
- **Regulate construction of, and abstraction from, wells**

  Empower agencies to monitor and licence deep wells and drillers.
- **Efficient irrigation water management**
  - ► Promote improved irrigation technologies.
  - ► Introduce water-saving irrigation practices and techniques, essential to manage the dry-season water demand and availability.
  - ► Promote a range of techniques and technologies for conservation of soil and water.
- **Reduce intrusion of chemicals into groundwater**
  - ► Awareness-raising on the excessive use of agrochemicals and water.
  - ► Change in farmer behavior through extension trainings in the use of fertilizers.

    Promote the use of biofertilizers.
  - ► Efficient irrigation water management to reduce nutrient leaching into the aquifer.
  - ► Introduce bioremediation.
  - ► Natural breakdown of hazardous substances into less toxic compounds thus repairing environmental damage.
- **Minimize the risk of intrusion of seawater**
  - ► Control high rates of extraction from vulnerable areas.
  - ► Rehabilitation of coastal wells.
  - ► Rehabilitation of the Jaffna Lagoon Scheme (barrages).
  - ► Control sand mining.
- **Improve the wastewater and fecal management:**
  - ► Minimize the infiltration of wastewater into the aquifers.
  - ► Reuse of the treated wastewater for irrigation is the best solution where the environment is concerned.
  - ► Proper disposal system.
  - ► Proper septic tank/soakage pit.
  - ► Maintain distance between domestic wells and septic tank/soakage pit.
- **Improve management of solid waste**
  - ► Proper disposal site.
  - ► Composting plant.
- **Strengthening public awareness on groundwater.**
  - ► Local educational programs are required to strengthen public awareness of the reasons for the poor quality and deteriorating nature of groundwater in the Jaffna Peninsula.

- **Empower regulatory committees**
- **Capacity building in Water Boards, CEA and related agencies**

4.6 The presentation on *Well data collection – Jaffna District (NWS&DB)* was made by Mr. N. Thaventhra Kumar.

Main aquifer
Chunnakam
Vadamarachchi East
Chavakachcheri
Kayts

Problems reported
Kerosene-like odor was continuously sensed in the water from the Chunnakam water supply intake. An odor was sensed in the pipe-borne supply of water too from the Chunnakam intake.

- Chunnakam intake and the surrounding wells were checked for oil/grease and oil/grease residues were identified in all wells.
- Several public complaints received from the Medical Officer of Health (MOH) of Chunnakam regarding oil and grease odor.
- *Pradeshiya Sabha* (PS) Chairman, Chunnakam called for a meeting of all relevant institutions and a site visit was arranged.
- MOH, CEA, Board of Investment (BOI), PS and NWS&DB jointly visited the site and MOH collected the samples from the Power Station at the oil dumping point. All samples showed oil/grease exceeding the CEA standard.
- Wells surrounding the Ceylon Electricity Board (CEB) power station were also checked by NWS&DB and were found to have residues of oil/grease.
- All analyses were carried out by the Central Laboratory, NWS&DB. The site at Chunnakam Intake was given up due to this contamination.
- The Pokkanai Intake is also contaminated but water is still pumped from it.
- MOH, CEA, BOI, PS and NWS&DB jointly visited the site and the MOH collected samples from the oil dumping point of the power station. In all samples there were oil/grease residues exceeding the CEA standard.

Problems were communicated to the following:

- Hon. Minister Douglas Devananda
- General Manager, CEB
- PS, Chunnakam, Government Agent, Jaffna and DS, Chunnakam
- Director General, CEA
- BOI
- MOH and Regional Director of Health Services

More than 102,011 wells are estimated to be in the Jaffna District (as per the statistical hand book 2011, District Secretariat) consisting of 15 DS divisions. Most of the wells are shallow dug-wells. But

no attempts have been made to collect details in respect of the water quality, usage of well, type of well, etc. Jaffna Peninsula depends totally on groundwater for all water needs: well mapping and data collection are very important for water management.

- Funded by United Nations Children's Fund (UNICEF)
  - 2010 - Rs 472,200.00
  - 2011 - Rs 435,800.00
  - 2012 - Rs 2,145,200.00
  - Collected data (Nos.) - 13,170
- Required amount = Rs 231.83/well (say Rs 250.00/well)

Objective of the Project

Collecting details of all existing wells required for future groundwater improvement and identifying and analyzing the groundwater behavior in the wet and drought seasons through creating a database (see Table 14).

From this survey we can identify the actual requirement of the people and the scarcity of water. Groundwater would be improved to give priority for water supply facilities. Identify the patterns of seawater intrusion, source of seawater contaminants and water-related history of the place.

TABLE 14. Estimated number of wells available in Jaffna District.

S. No.	DS Division	Total no. of wells
1	Delft – Delft	941
2	Islands South – Velanai	2,881
3	Islands North - Kayts	1,904
4	Karainagar – Valanthalai	1,825
5	Jaffna – Chundikuli	7,227
6	Nallur – Nallur	13,157
7	Valikamam West – Chankanai	7,585
8	Valikamam South West - Sandilipay	8,189
9	Valikamam East – Kopay	11,866
10	Thenmaradchi – Chavakachcheri	17,318
11	Vadamarachchi North – Point Pedro	6,784
12	Vadamarachchi South West - Karaveddy	7,269
13	Vadamarachchi East - Maruthankerney	1,849
14	Valikamam South – Uduvil	9,102
15	Valikamam North – Tellippalai	4,114
	Total	102,011

Completed works

Data collection on wells at the Karainagar, Kayts, and Velanai DS Divisions is completed.

- Karainagar DS Division – 2,697 wells were identified and data were recorded and mapped (as per the statistical book only 1,825 wells were reported).
- Kayts DS Division – 2,211 wells were identified and data were recorded and mapped (as per the statistical book only 1,904 wells were reported).

- Velanai DS Division – 8,206 wells were identified and data were recorded and mapped (as per the statistical book only 2,881 wells were reported).
- Data collection on wells at Chankanai DS Division has not yet been completed due to the unavailability of funds – 893 wells were identified and data were recorded and mapped; expected around 10,000 wells (as per the statistical book only 7,585 wells were reported).

Targets

- All wells located in the Jaffna Peninsula to be identified and mapped (102,011).
- A well-organized database should be created.
- Identify the actual water requirements.
- Identify the required groundwater protection.

Requirements
Funding for collectors of data on wells and vehicles - Rs 250.00/well

- Logistical support
  - No. of Ec meters – 04
  - No. of pH meters – 04
  - No. of Dip meters – 04
  - No. of Geo Positioning Systems – 02
  - No. of laptop computers – 02

Discussion time

Her Lordship, the Mayor of the Jaffna city:
I want to ask one question about the presentations. I feel that nobody mentioned about the regulations of the Urban Development Authority. To accommodate an urbanization pattern, especially in Jaffna, we have to provide underground parking places. In the limestone areas how can we provide underground parking places? Is it possible to block the connectivity of underground streams?

According to my understanding about engineering, there are better engineers here or practicing engineers so that you can have underground parking but you have to invest a lot of money for sealing so that water will not come in. So if it is sealed the connectivity of the streams could be arrested.

A participant responded (…. His response was not clear).

Her Lordship's counterresponse:
Yes. Parking will not be required all over the place. The area assigned for parking a particular number of vehicles, e.g., 100 cars, etc., can be determined.

A Participant: Madam, when there is an underground limestone base water flow from one location to another will be similar to the flow in a pipe. If streams are blocked then there will be issues of recharging groundwater so that the issue needs to be addressed.

The second issue I want to address is when there is urbanization what is the minimum number of perches allowed for a house? In the past, it was 10 *parappu* (a unit of measurement of land). It was 10 perches in some areas like Kurunagar.

At the same time, no one has given attention to evaporation losses. A study needs to be carried out to assess it. In this study it is not only the effect of surface water bodies but also of groundwater that

needs to be considered because it is a shallow aquifer. We have to monitor the temperature and other aspects too to come up with feasible solutions because all are focusing on the underground reservoir of groundwater. Another important factor to be considered is the average potential evaporation in Jaffna, that is 1,800 mm whereas the annual rainfall in Jaffna is 1,200 mm.

A Participant: Madam, the regulations passed on stormwater are now being implemented. Anybody who wants to construct a house in Colombo has to have a rainwater harvesting system in the design and plan before getting approval for construction. It has been implemented not only in the Colombo municipal area but even in the Kaduwela area close to the Parliament.

We can introduce a second regulation for the construction of septic tanks. The issue is that sealed septic tanks are getting filled up and need emptying from time to time. The sludge removed from these tanks could be processed into fertilizer. The Soyza Pura Housing Scheme of Moratuwa, South of Colombo, is one site that is practicing this technology. Those authorized by this scheme sell this material (sludge) at a premium price, which is higher than the price of compost made out of garbage.

We also need to work on the tourism sector (including hotels). Our officials have enough knowledge and experiences now.

I hope we answered your questions.

Thank you.

5. Group discussions and presentations

After presentations were made all participants were requested to join one of the following four groups (5.1 to 5.4).

5.1 Agree upon rules for sustainable and equitable groundwater management

a) Quantify available groundwater resources.
b) Increase recharging mechanism.
c) Form a district law enforcement committee chaired by the GA and link it to the national-level system.
d) Real-time monitoring system to be established on a long-time basis (WRB and NWS&DB collected data for a short time period; and stored and disseminated them to groundwater users).
e) Formulate extraction rules to share common resources and to maintain sustainability (without pollution).

5.2 Mitigate pollution threats

Short term

a) Continuous data collection – water resources must be accessible.
b) Subsidies on agrochemicals and fertilizers should be given only for paddy cultivation.
c) Financial assistance to be given to those who use organic fertilizers.
d) Better monitoring should be done by the health and agricultural sectors.
e) Infected waste from hospitals should be sent to incinerators.
f) Municipalities and urban authorities should develop proper garbage disposal methods.
g) The public should be educated on pollution threats.

Long term

a) Results of research conducted on water resources in Jaffna by the university and the Water Board should be discussed at management committees to identify problems.

5.3 Reduce demand on aquifers by making the most of other water sources

a) Reuse wastewater - Use treated urban wastewater for irrigation, e.g., The sanitation project of the Jaffna Municipal Council will receive approximately 3 ac.ft/day (3,200 m^3/day) of water for irrigation in Valukaiaru.

b) **Low water usage**

Perception/Attitude
Easiness - Availability of reliable water pumps – But more initial capital cost (including damage caused by animals, and depreciation of water pumps).

c) **Adoption of water-smart technologies**

Pass legislation by local authorities.
Less usage of water for domestic purposes.
Canal lining in water distribution.
Used water for toilet flush.
Plowing land before rainy season.

d) **Increase water storages**

Investigation of underground water.
Rainwater harvesting must be done at individual level by introducing strict laws.
Temporary retention of rainwater.
Paving urban area.
Increase/introduce recharging of wells.
Desilting of tanks.
Reintroduce ditches in private properties (precautions against dengue mosquito breeding).

5.4 Inform, educate and collaborate

1) Device cost-effective groundwater extraction rules.
   Identify overextracting places, industries, etc.
   Awareness-raising programs are functional; rectify where there are blocks and remove any bottlenecks.
   Continuous usage of media for awareness-raising programs.
   Introduce scientific approaches for implementation of proper rules.
   Indiscriminate waste of water by the public to be addressed through schools.
2) Ways of carrying out what is given in 1) above.
   a) Conducting awareness-raising programs at public gatherings such as temple festivals, public programs, carnivals, exhibitions, etc.
   b) Communicate messages through the TV, newspapers and other media.
   c) Distribute comprehensive prints and documents on water issues.
   d) Depopulating through a constructive government plan for water management.
   e) Develop/identify success stories for dissemination.
   f) Careful planning and implementation needed for massive projects and settlements.
      Awareness-raising packages should include suggestions.
      Identify feedback mechanisms on outreach of messages.
      Attitude changes should be monitored.

3) Means of carrying out what is given in 1) above.

- All awareness-raising programs need to include facts and figures that will be welcomed by the public.
- All recommended approaches should be cost-effective.
- The law should be amended to be in line with supporting public awareness-raising programs.
- People should be aware that good water is essential for life.
- Personal issues to be solved to focus on health. This can be tackled by involving Public Health Inspectors (PHIs), PS, Medical Officers of Health.
- Already functioning mothers' clinics can be used.
- Identify local media channels to use them for transmitting awareness-raising programs for the public.
- Prepare comprehensive documentations.
- Identify media channels – the TV, newspapers.
- Starting from preschool and reaching tertiary and higher educational institutions.
- Inform government institutions, NGOs, the private sector and the public through INGOs and NGOs.
- Awareness-raising through community-based organizations.

5.5 Presentation by students of the Jaffna University

Students of the University of Jaffna made their presentation last appreciating the concern of all about the governance of groundwater in Jaffna and requested all to preserve the precious groundwater resource, managing it with utmost care not only for their generation but for future generations too.

6. Summing up and vote of thanks

Concluded the meeting proceedings hoping to meet the members of the water management committee soon.

7. Names of Participants

1. Mr. G.A. Chandrasiri, Hon. Governor, 9/1, Lily Avenue, Jayanthipura, Battaramulla, gachandrasiri@yahoo.com, npcgovernor@gmail.com, Fax. 0112885436,M. 0772260888
2. Eng. G. Sarwanabawan, Senior Program Officer (Contract Management) – DSWRP Project, represented Secretary M(I&WRM), MASL Building, No. 500, T. B. Jaya Mawatha, Colombo 10, M. 0773040857
3. Eng. T. Wickramasinghe, Director, representing Secretary Ministry of Water Supply & Drainage, "Lakdiya Medura", No.35, New Parliament Road, Pelawatta, Battaramulla
4. Mrs. R. Wijialudchumy, Chief Secretary, Chief Secretary Office, 187, Aadiyapatham Road, Thirunelveli, Jaffna, chiefsecnpc@gmail.com, T. 0212220843, M. 0773868569
5. L. Illaangovan, Secretary to the Hon. Governor, 9/1, Lily Avenue, Jayanthipura, Battaramulla npcgogernor@gmail.com, T. 0212220660,61, M. 0773868565
6. Mr. Nihal Samarakoon, Coordinating Secretary to the Hon. Governor for Jaffna, 9/1, Lily Avenue, Jayanthipura, Battaramulla, samarakoon.nihal@gmail.com, M. 0770778504
7. Mrs. Yogeswari Patkunarajah, Hon. Mayor of the Jaffna City, Mayor's Office, Point Pedro Road, Jaffna, info@jaffnamc.lk, Fax. 0212221189, T. 0212221186/89

8. Mr. V. Kengatharan, Development Officer representing Divisional Secretary – Nallur, Point Pedro Road, Nallur, dsnalur@yahoo.com, T. 0212229801
9. Mr. M. Pradeepan, Divisional Secretariat - Valikamam East, Divisional Secretariat, Valikamam East, Kopay, valieast@gmail.com, Fax. 0212231211, T. 0212230013
10. Mr. K. Shanthamohan, Divisional Secretariat - Valikamam North, Divisional Secretariat, Valikamam North, Tellippalai, dstellippalai@gmail.com, M. 0776033312
11. Mrs. R. Bhanumathy – Development Coordinator representing Divisional Secretary - Valikamam South West, Sandilipay, smuralitharands@gmail.com, T. 0212255550
12. Mr. V. Sivakumar –Assistant Director, Planning, representing Divisional Secretary - Valikamam West, Valikamam Sothy26@yahoo.com, T. 0212250044, M. 0773618499
13. Mr. S. Sivakumar, Provincial Director of Agriculture - Northern Province, 466/1, Moothathamby Avenue, Nallur, npagri@yahoo.com, T. 0213202619, M. 0773868581
14. Mr. V. Elankumar, Deputy Provincial Director of Agriculture – Northern Province, 466/1, Moothathamby Avenue, Nallur, Jaffna, ddajaf@gmail.com, M. 0778349847
15. Eng. N. Suthakaran, Deputy Director Irrigation - Northern Province, Kachcheri Lane, Kandy Road, Killinochchi, npirrigation@yahoo.com, T. 0212285440, M. 0773868575
16. S. Shanmuganathan, Deputy Provincial Director Irrigation – Northern Province, Kachcheri Lane, Kandy Road, Killinochchi, npirrigation@yahoo.com, M. 0777158570
17. Mr. V. Kulatungan representing Deputy Commissioner, Department of Agrarian Development, Point Pedro Road, Nallur, dadjaffna@yahh.com, T. 0122222396
18. Prof. G. Mikunthan, Dean of the Faculty of Agriculture, University of Jaffna, Thirunelvely, Jaffna, gmikunthan@gmail.com, Fax. 0212222973, M. 07118475539
19. Dr. Mrs. T. Mikunthan, Senior Lecturer G1, Department of Agricultural Engineering, University of Jaffna, Thirunelvely, Jaffna, thushym@jfn.ac.lk, M. 0777111339
20. Dr. S.S. Sivakumar, Coordinator - Engineering Faculty, University of Jaffna, Thirunelvely, Jaffna, Sssiva100@yahoo.com, Fax. 0212222685, M. 0772508730
21. Mr. Gunalan, Lecturer, Ocean University, 2nd Cross Street, Kurunagar, Jaffna, Guna.uor@gmail.com, Fax. 0212226251, M. 0772314076
22. Mr. M. Hidayatulla, Provincial Manager – Northern Province, Water Resources Board, 699, Point Pedro Road, Jaffna, mhmohameds@yahoo.co.uk, T. 0212227268
23. Eng. Duleep Gunawardena, Deputy General Manager, Regional Support Centre (Northern), NWS&DB, Mannar Road, Vavuniya, duleepgo@gmail.com, T. 0242225719
24. Eng. B. Thaventhr Kumar, Regional Manager, Regional Support Centre (Northern), National Water Supply & Drainage Board, Kandy Road, Jaffna, rmjaffna@yahoo.com , Fax. 0212227965, M. 0777864546
25. Eng. Bharadidasan, Project Director, JKWSSP, National Water Supply & Drainage Board, Kandy Road, Jaffna, pdjkwssp@gmail.com, Fax. 0212220257, M. 0777871235
26. Mr. S. Senthuran representing Mrs. Vijitha Sathiyakumar, Assistant Director - Northern Provincial Office, CEA, Kachcheri, Jaffna, ceasrojf@sltnet.lk, Fax. 0212224050, T. 0217877277, M. 0718175805
27. Eng. S. Balasingham, Team Leader of Consultant Infotechs, IDEAS PLC JKWSSP-IC, Iranamadu Water Supply Project, Irrigation Compound, Kanakambikai Amman Kovilady, Iranamadu, Killinochchi, Balasing745@gmail.com, M. 0718601548

28. Mr. K. Pooranachandran, Chairman of the Chamber of Commerce and Industries of Yarlpanam, 124, Rasavin Thoddam Road, Jaffna, Kpc281@gmail.com, M. 0777570215

29. Mr. S. Kailasapillai, Managing Director, Ganam Hotel (Pvt) Ltd, 299,301 Clock Tower Road, Jaffna gnanams@sltnet.lk, Fax. 0212220631, T. 0212220630/1/2/3

30. Eng. J. Senthan, Managing Director, Jeyantha Industrial Park (Pvt) Ltd, School Road, Katkovalan, Point Pedro, tsenthan@yahoo.com, Fax. 0215671025, M. 0777482339

31. Mr. Abdulai Kaikai, UNICEF, Chief - Water, Sanitation, Hygiene (WASH) section, United Nations Children's Fund, Country office, 35, Balapokuna Road, Colombo 5, akaikai@unicef.org, Fax.2832497, M. 0773166528

32. Dr. Kuruppuarachchi, Assistant FAO Representative (Programme), 202, Bauddhaloka Mawatha, PO. Box 1505, Colombo, FAO_LK@fao.org, T. 0112580798, M. 0773659055

33. Martin Studen, Deputy Country Director, Swiss Agency for Development and Cooperation , Swiss Cooperation Office, Sri Lanka, Wyman Rd, Jaffna.

34. S. Yuganeethan, GIZ, No. 6, Jawatte Avenue, Colombo 5. Stefan.Oehrlein@giz.de, T. 0112504744/5, M. 077264583

35. Dr. N. Sivarajah, Regional Coordinator, WHO, 135, Temple Road, Nallur, Jaffna, sivarajahn@searo.who.int, nsivarajah@gmail.com, Fax./T. 0210006067, M. 0777562715

36. Lt. Col. WMAB Wijekoon representing General N. Hathurusinghe, Army Commander – Jaffna Security Forces Head Quarters, Army Camp, Jaffna, T.0212222112, M.077308191

37. Eng. R.V. Peris representing Eng. S. K. Liyanage, Project Director – Emerging Northern Re-Awakening Project, Ministry of Economic Development, Project Management Unit, Kanniya Road, Varayodayanagar, Trincomalle, pd@enrep.lk, M. 0777517353

38. Mr. Ruwan Rajapakse, Senior Hydrogeologist, Water Resources Board, 2A, Hector Kobbekaduwa Mawatha, Colombo 07, ruwanst@yahoo.com , M. 0712857480

39. Mrs. L. Janakan

40. S. Ridika, UNICEF

41. Sarath De Silva, Consultant to the Water Resources Board

42. Chameera Kumar - Hydrologist, WRB

43. T. Sarvantha, Director (planning), Ministry of Agriculture, NCP

44. S. M. C. Croos, Former GA, Mannar

45. S. Sarwanan, Chemist, NWS&DB, Jaffna

46. Eng. R. Suweenthan, NWS&DB, Jaffna

47. A. Kirupathasi

48. K. Sugesan, Sevalanka Foundation

49. A. C. Rosairo,

50. S. Kopythevsan, Technical Assistant, GIS.

51. K. D. W. Nandalal – Consultant, NWS&DB

52. V. Bama, University of Jaffna

53. K. Kajenthiny, University of Jaffna

54. S. Swarna University of Jaffna

55. S. Gobika, University of Jaffna

56. T. Keerthiga

57. K. Thaneshwaran, DPA

58. B. Mathive

8. References

Arumugam, S. 1970. Development of groundwater and its exploitation in the Jaffna Peninsula. Paper read at the Annual conference, October 1970. The Institution of Engineers, Ceylon.

Balendran, V.S.; Sirimanne, C.H.I.; Arumugam, S. 1968. *Groundwater resources of Jaffna Peninsula*. Colombo, Sri Lanka: Water Resources Board, Colombo.

De Alwis, K.A.; Panabokke, C.R. 1972. Handbook of soils of Sri Lanka (Ceylon). *Soil Science Society, Ceylon* 2:1-97.

Feasibility Report. 2006. *A feasibility study for water supply and sanitation system for the Jaffna Peninsula.* ADP Project. Project No: 5068020. Jaffna, Sri Lanka: National Water Supply and Drainage Board.

Gunalan, K.; Asanthi, H.B.; Gamage, T.P.D.; Thushyanthy, M.; Saravanan, S.; Jayakumaran, N. 2011. Incidence of oesophageal and stomach cancer related to nitrate-N concentration in groundwater in Jaffna Peninsula. The water resources research in Sri Lanka. In: Symposium proceeding of the water professionals' Day-2011, 91-103, ed. Dayawansa, N.D.K; De Silva, Ranjith Premlal; Gunasekaram, T. 1983. *Groundwater contamination and case studies in Jaffna Peninsula, Sri Lanka.* Jaffna: Global Engineering Technology Services.

Gunasekaram, T. 1983. *Groundwater contamination and case studies in Jaffna Peninsula, Sri Lanka*. Jaffna: Global Engineering Technology Services.

Jaffna District Statistical Hand Book. 2011. *Annual publication.* Jaffna: District Secretariat.

Kraft, H. 2002. Study on water supply, rain water harvesting, waste water and solid waste management in Jaffna municipal council. *Jaffna Rehabilitation Project (JRP)*, January, 2002. Sri Lanka: GTZ., pp. 13-33.

Mageswaran, R. 2003. Quality of groundwater in the Jaffna Peninsula. International workshop on environmental management in north-east Sri Lanka. 1st-4th December, 2003. Jaffna, Sri Lanka.

Navaratnarajah, V. 1994. Water problems in the Jaffna peninsula. 20th WEDC International Conference in AFFORDABLE WATER SUPPLY AND SANITATION. 1994, Colombo, Sri Lanka, pp. 191-193.

Panabokke, R.G. 1984. The geographical pathology of malignant tumors in Sri Lanka – a 5-year study. *Ceylon Medical Journal* 29: 209-224.

Sirimanne, C.H.L. 1952. The geology for water supply. Compiled by Arumugam, S. 1974. *Studies on groundwater in Sri Lanka.* Colombo: Water Resources Board, pp.31-58.

Sirimanne, C.H.L.; Vaidya, G.D. 1955. The occurrence of ground water in Ceylon. A paper presented at symposium organized by the Central Board of Geophysics, Government of India in 1955, on "Ground Water", published in Calcutta in 1958.

Sivarajah, N. 2003. Health related problems of water pollution in Jaffna. International workshop on environmental management in north-east Sri Lanka. 1st- 4th December, 2003. Thirunelvely, Jaffna, Sri Lanka, pp. 89-94.

Contact Information

Dr. Herath Manthrithilake
Head, Sri Lanka Development Initiative
International Water Management Institute
127, Sunil Mawatha
Pelawatta, Battaramulla
Sri Lanka
Telephone: +94-11 2880000
E-mail: h.manthri@cgiar.org
Website: www.iwmi.org