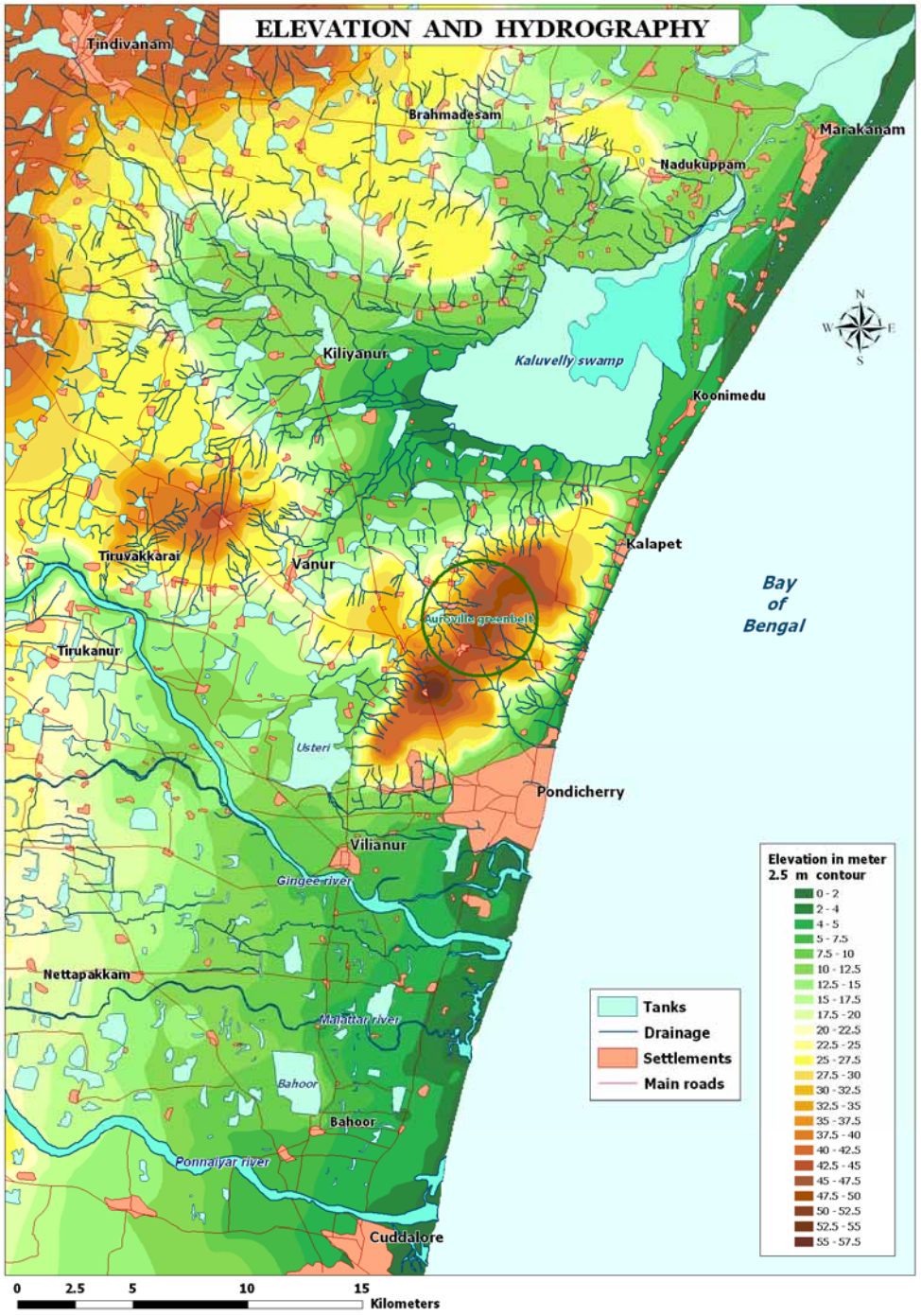
Auroville

Toward Water Security

April 2019

Gilles B. & Water Group



Overview

1. Core Issue
2. Background on general, regional & Auroville context
3. Water management: a way forward
   a. Water Consumption
   b. Water Sourcing
      Ground Water
      Rainwater Harvesting
   c. Water Supply
   d. Wastewater Management
   e. Multi Sourcing
4. Financial Requirements

Auroville - Core Issues

- Auroville is facing a water crisis
- Water Security cannot be ensured anymore
- Present management through groundwater recharge alone is not adapted anymore

- Entire dependency on Groundwater resources alone
- Depletion and degradation of Groundwater at regional scale

- NO!

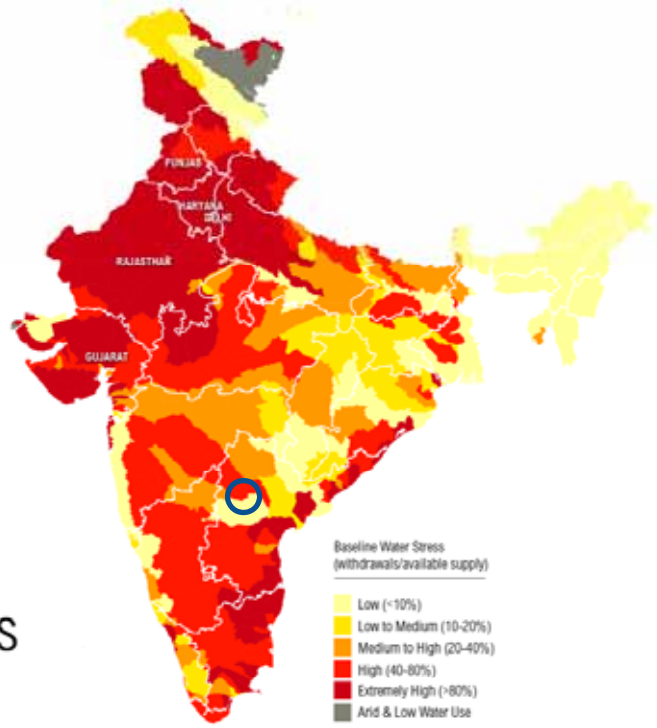
Do we have a plan of action?

- Yes!

General Context

Water Stress in India

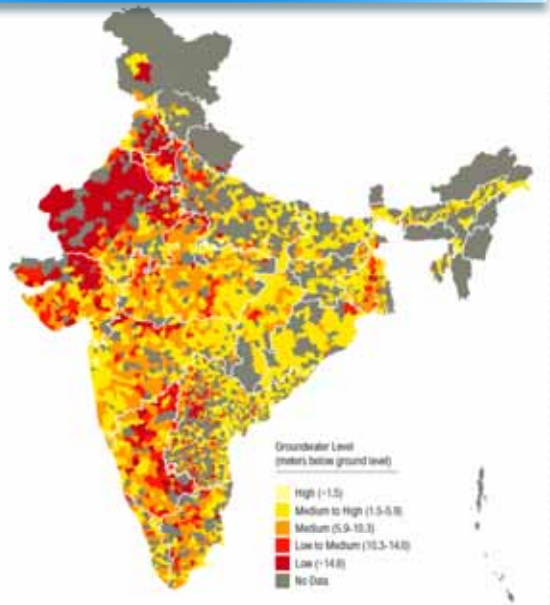
54% of India Faces **High** to **Extremely High** Water Stress



URBANIZATION

- About 30% of Indian population lives in cities today.
- Urban population will double by 2050.
- More than 100 Indian cities ≥ 10 lakhs people by 2030

54% of India's Ground-water Wells Are Decreasing



www.indiawatertool.in

WORLD RESOURCES INSTITUTE

Regional Context

Groundwater exploitation

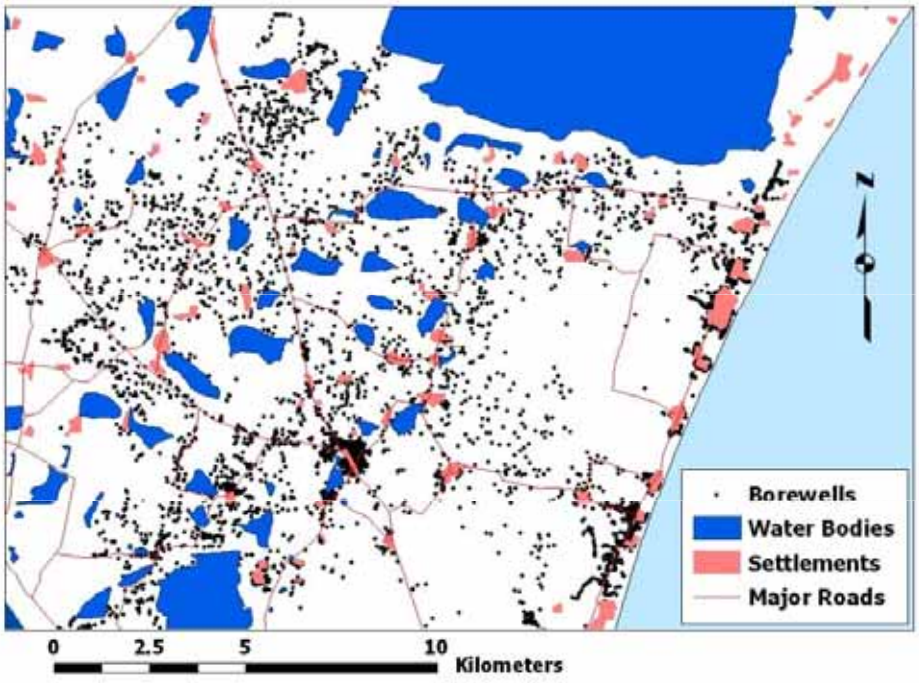
Exponential development of wells

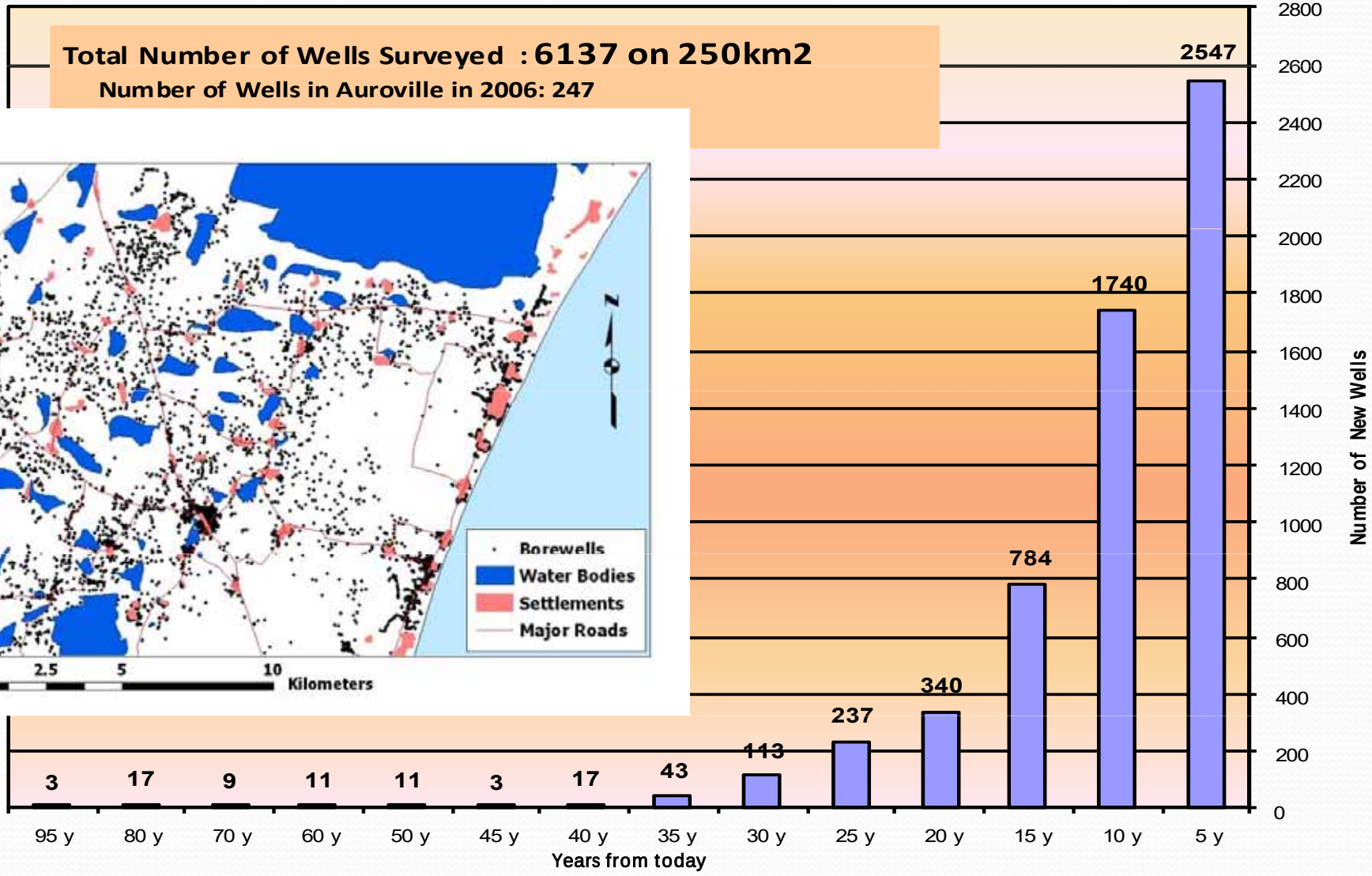
Wells Development through time in Auroville Area

(Ref: Auroville Water Harvest -**2006**)

Total Number of Wells Surveyed : 6137 on 250km2

Number of Wells in Auroville in 2006: 247





Overexploitation of Groundwater

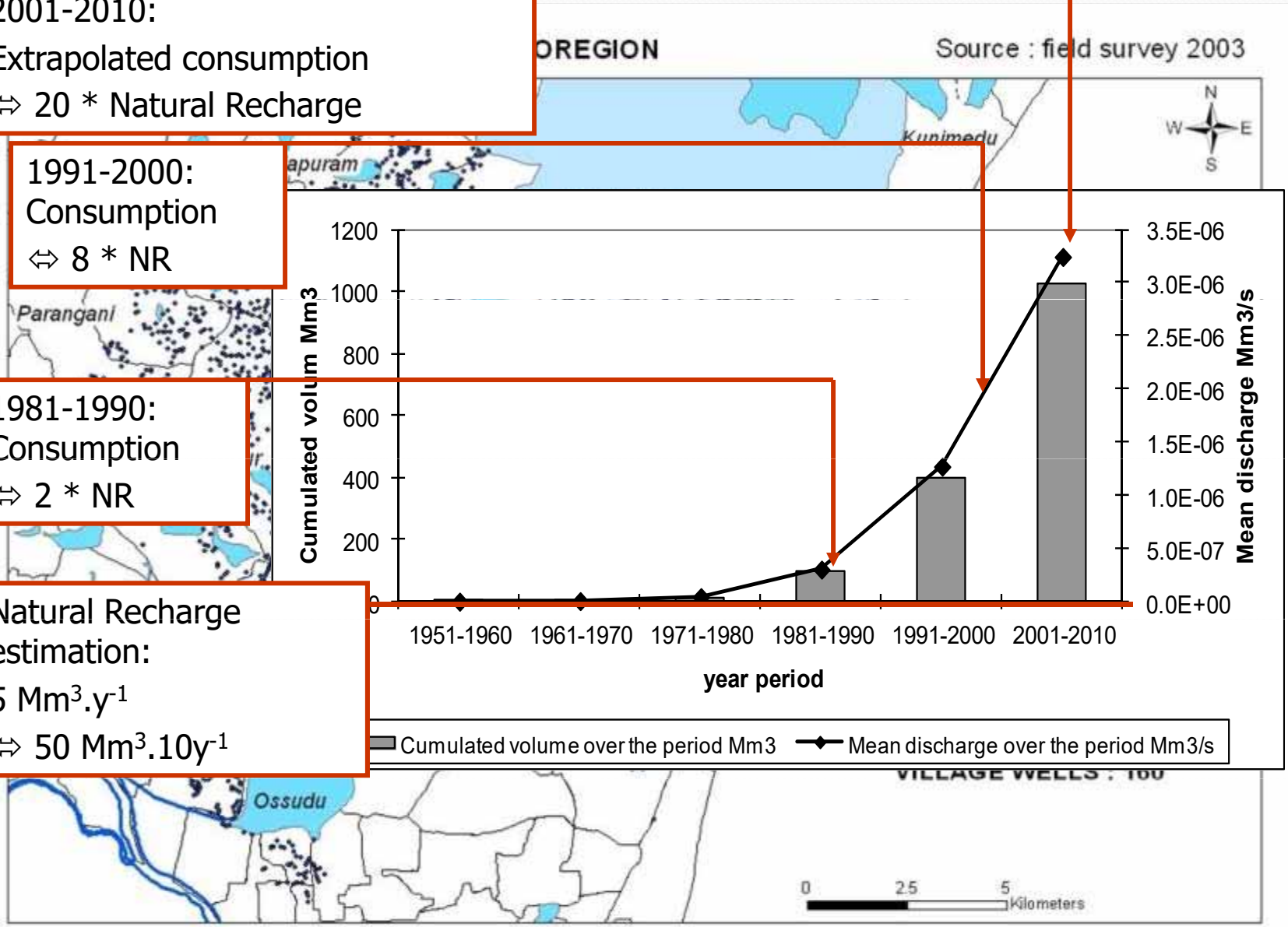
Evolution of extraction on Vanur Aquifer

2001-2010:
Extrapolated consumption
⇔ 20 * Natural Recharge

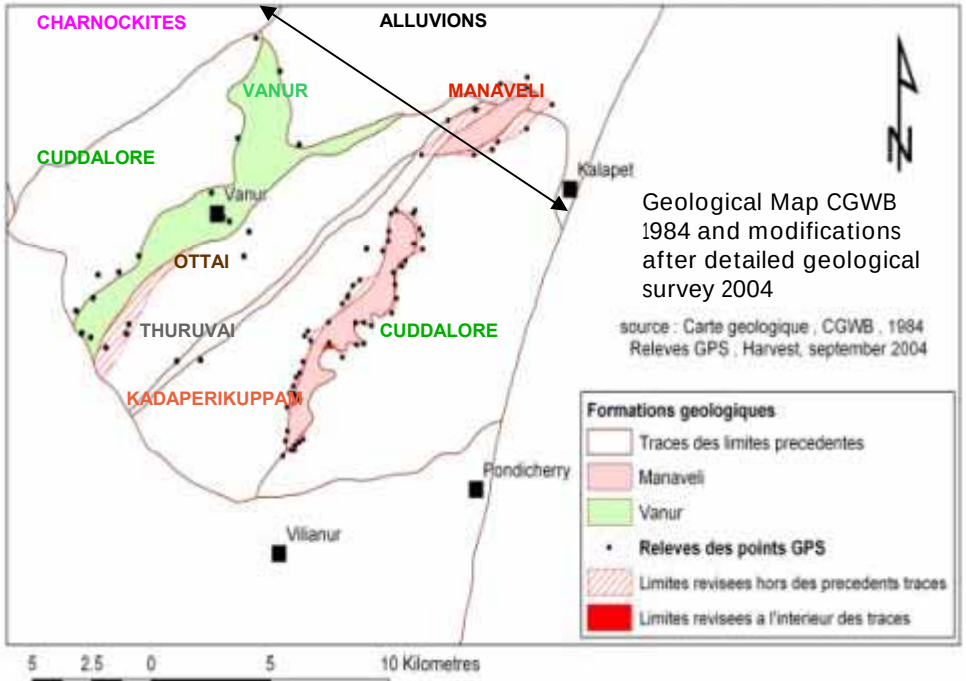
1991-2000:
Consumption
⇔ 8 * NR

1981-1990:
Consumption
⇔ 2 * NR

Natural Recharge estimation:
5 $Mm^3.y^{-1}$
⇔ 50 $Mm^3.10y^{-1}$

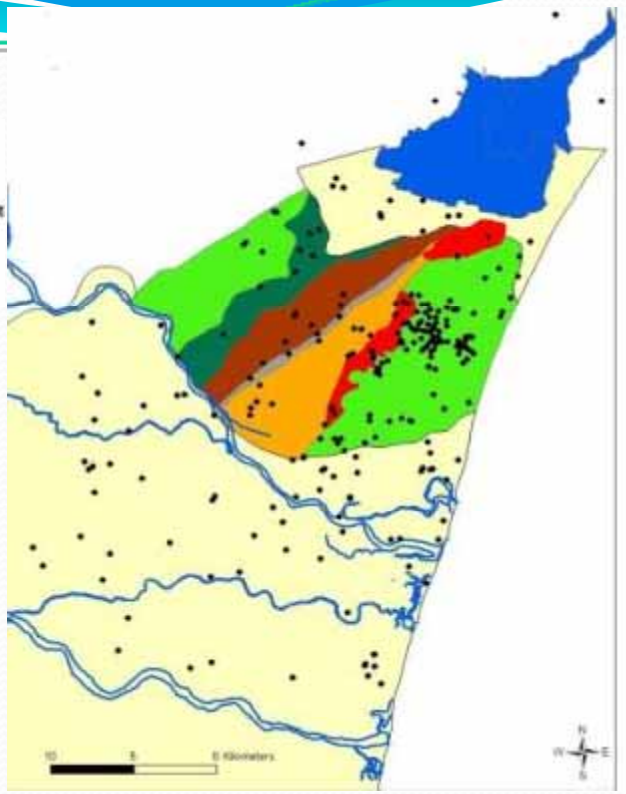


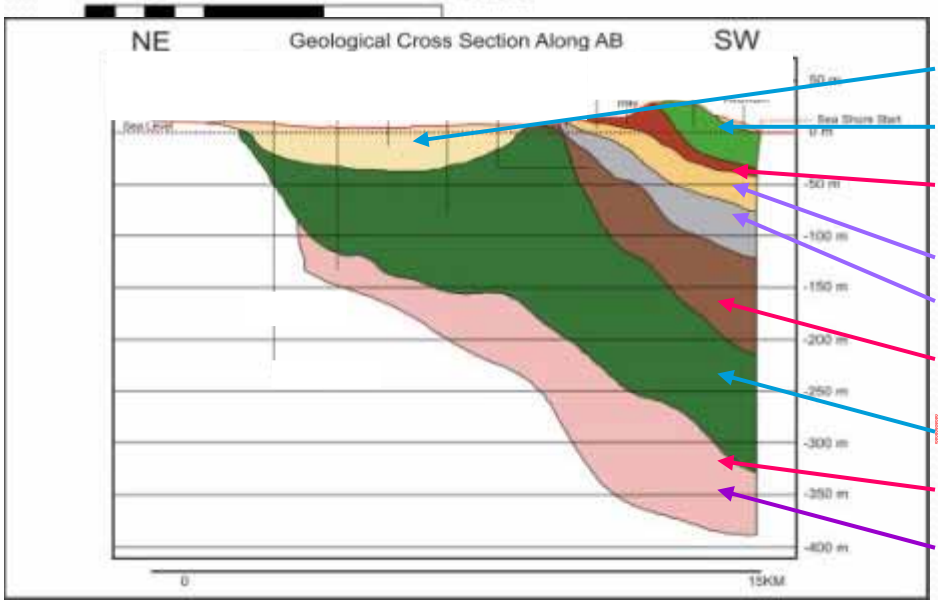
Groundwater Flow Modelling



Geological Map CGWB 1984 and modifications after detailed geological survey 2004

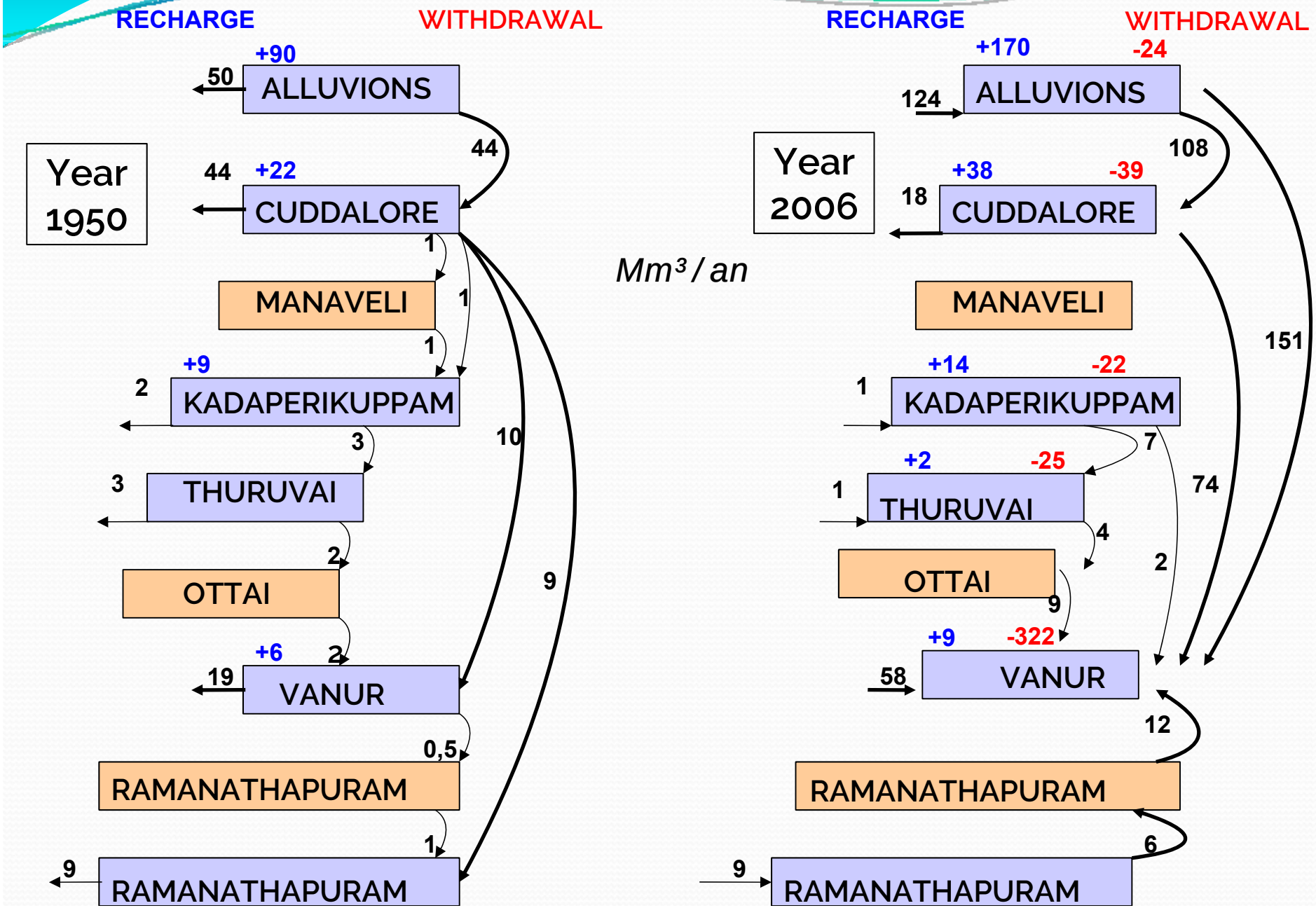
source : Carte geologique , CGWB , 1984
Releves GPS , Harvest, september 2004





ALLUVIUMS	ALLUVIONS GOOD PROPERTIES
CUDDALORE SANDSTONES	AQUIFER GOOD PROPERTIES
MANAVELI CLAY	AQUITARD
KADAPERIKUPPAM CALCAROUS	AQUIFER MINOR IMPORTANCE
THURUVA CALCAROUS	AQUIFER MINOR IMPORTANCE
OTTAI CLAY	AQUTARD
VANUR SANDSTONES	AQUIFER GOOD PROPERTIES
RAMANATHAPURAM CLAY	AQUITARD
RAMANATHAPURAM SANDSTONES	AQUIFER SULPHATE-RICH

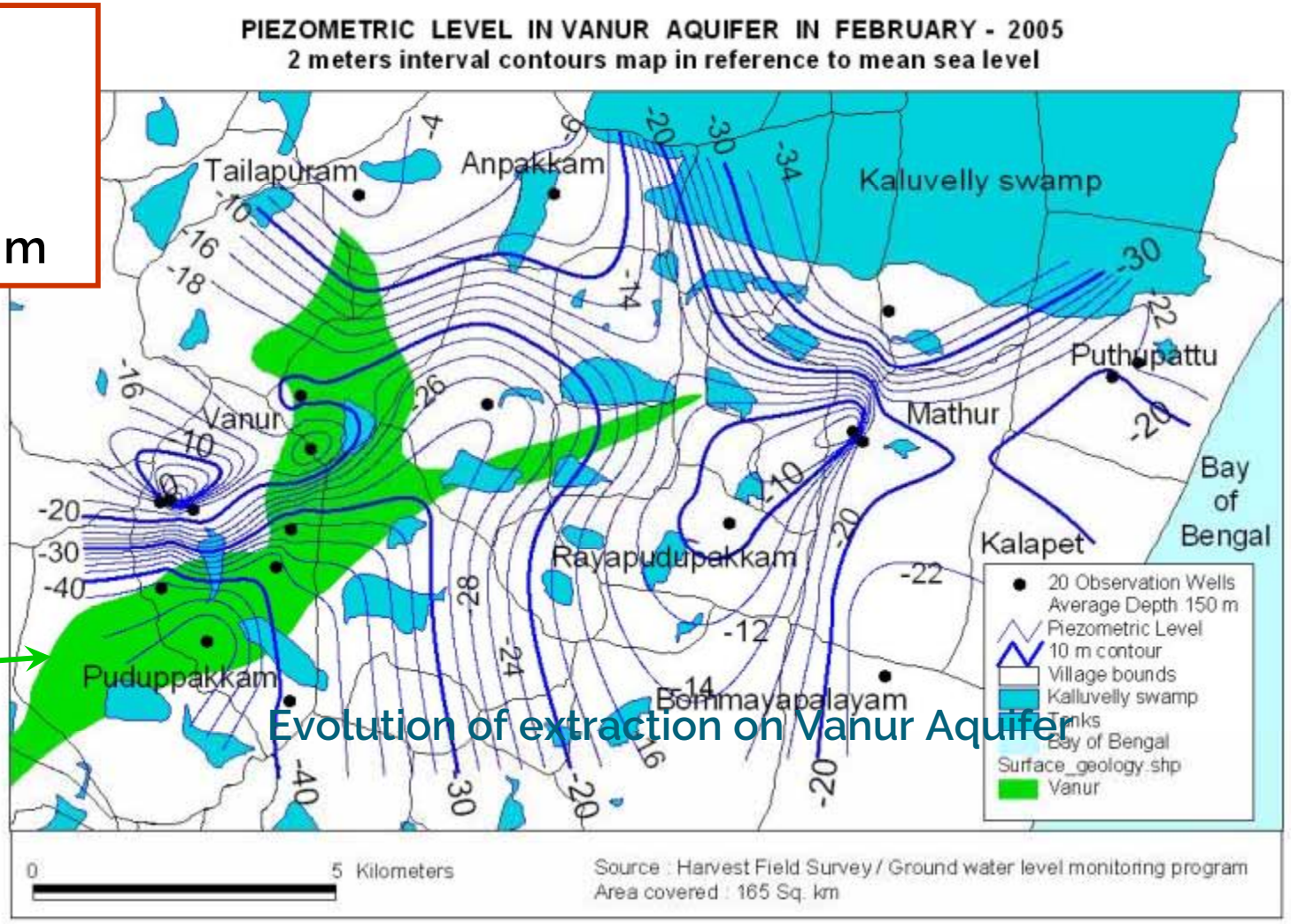
Groundwater Flow Modelling - Water Balance



Hydrogeology – Vanur aquifer, main aquifer of the area

water level
1975: +7 m msl
2005: -47 m msl
= drawdown ~54 m

Vanur outcrop area



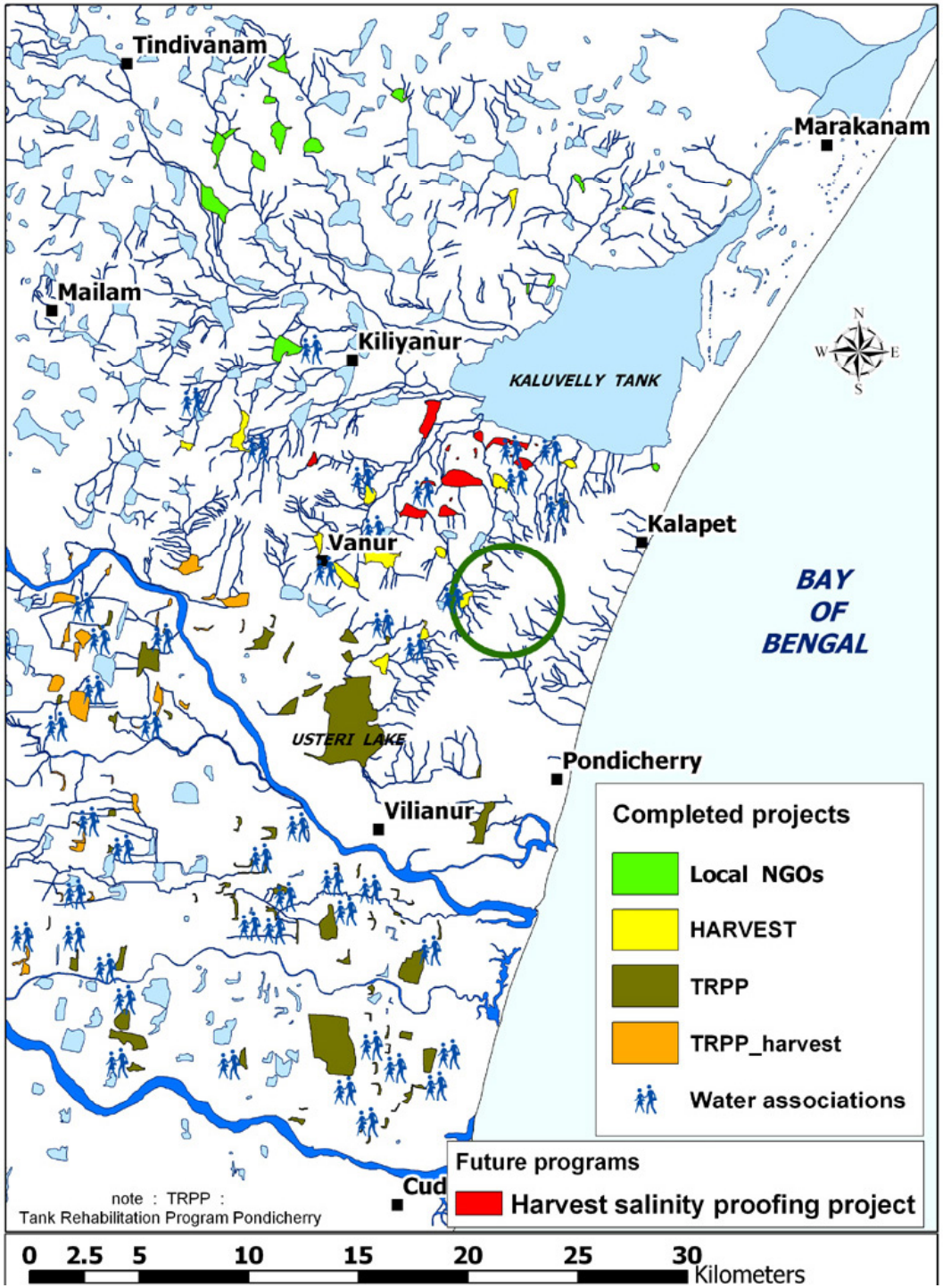
- Piezometric map: overexploitation of groundwater

Some of the multiple actions taken

Improved Water Management

- ✓120 Irrigation Tanks Rehabilitated
- ✓Ground water recharge
- ✓Water saving agriculture
- ✓Network of Water User Association created

BUT WHAT IS LEFT TODAY?



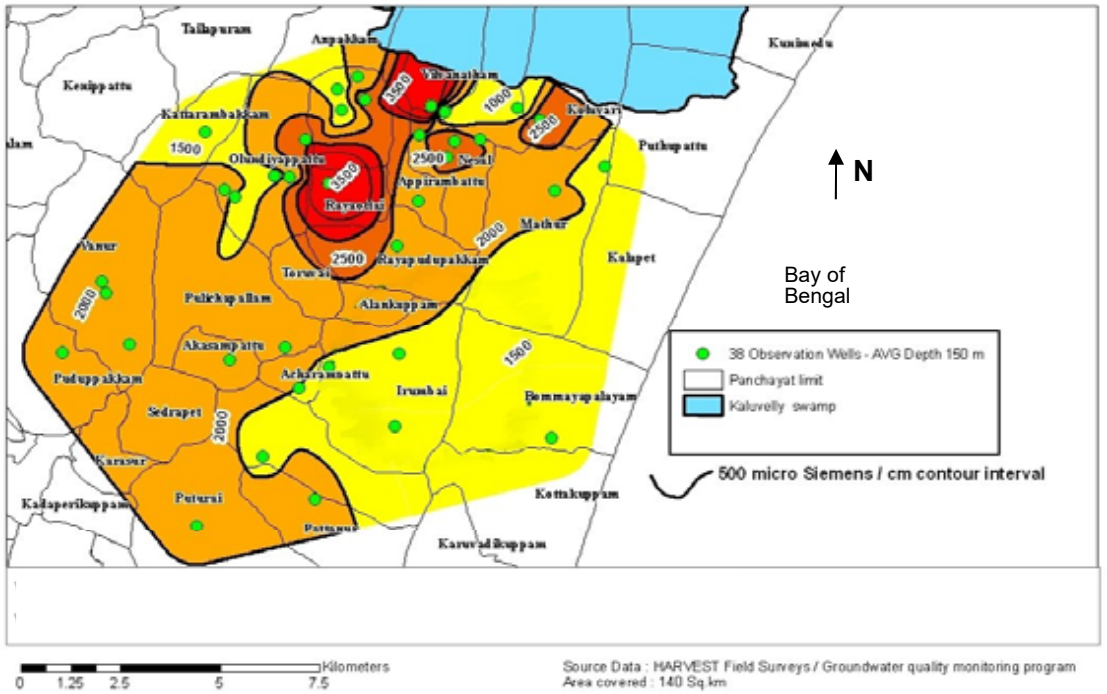
Hydrogeology - Vanur Aquifer

Aquifer mineralization

High mineralization recorded since 1996

red areas > 3 g/L (3,000 µS/cm)

Standard threshold values from WHO
- drinkable water 1 g/L (1,000 µS/cm)
- irrigation ~1.5 g/L (1,500 µS/cm)



Geochemical study 1999-2003 of 250 km² of the northern part of the sedimentary basin *d'Ozouville et al., 2006, Paris 6 University, Tours University, Rennes University, IPGP*

Source of Salinity in 2007:

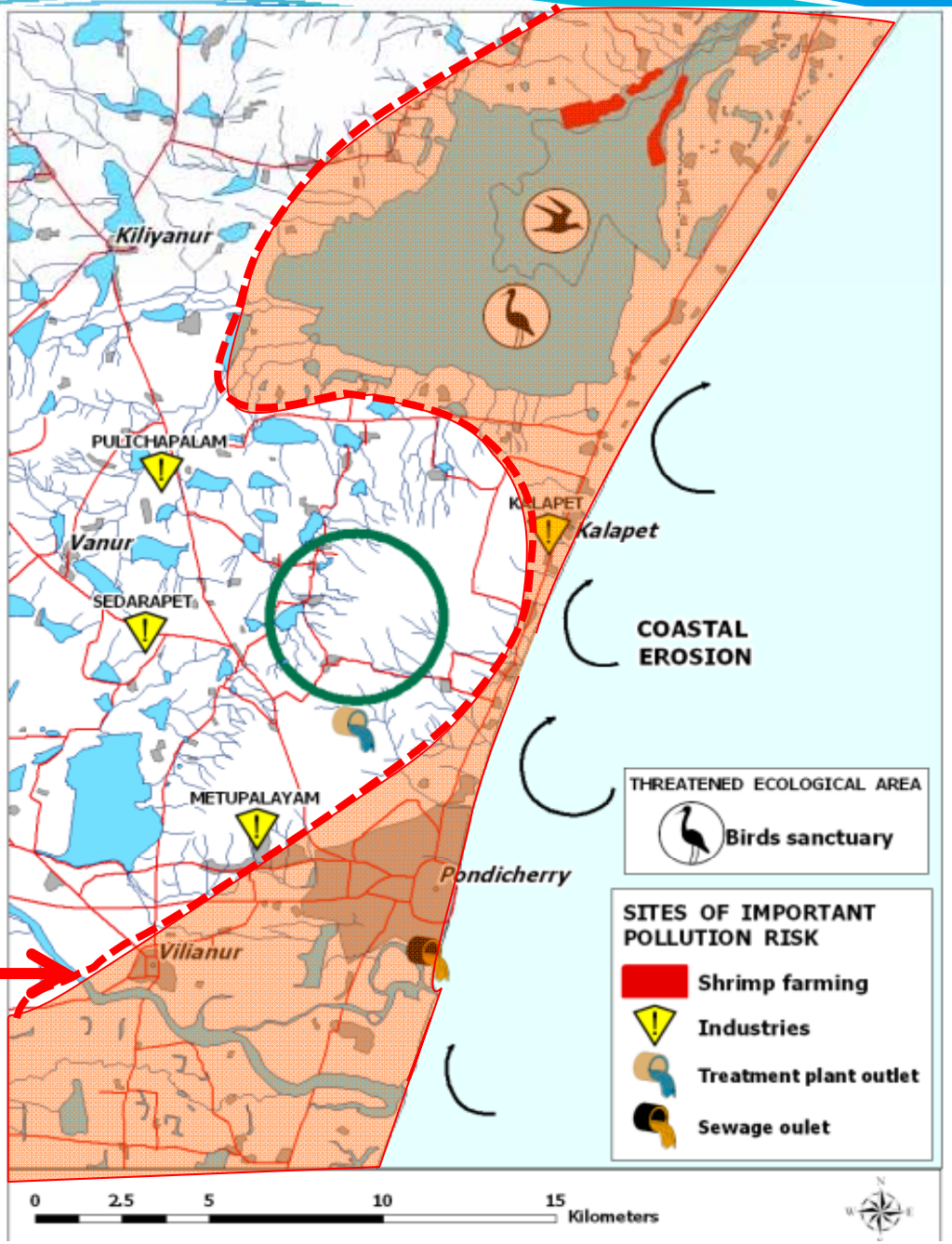
- Upward leakage of sulphate-rich water coming from the Ramanathapuram aquifer due to water level depression in the Vanur aquifer
- Brackish water coming from Kaluvelli swamp
- Human activities like fertilizers accumulation and irrigation return flow

Environmental Degradation

Main issues

- Overexploitation of groundwater
- Reduced recharge
- Absence of management of water resources
- Contamination of groundwater by seawater intrusion
- Prowling Urbanisation
- Poor regulation

Approximate limit of Seawater Intrusion



But also:

- Infrastructure development
- Non-Source Pollution
- Solid waste disposal
- Lack of sanitation facilities
- Fragilized eco-system

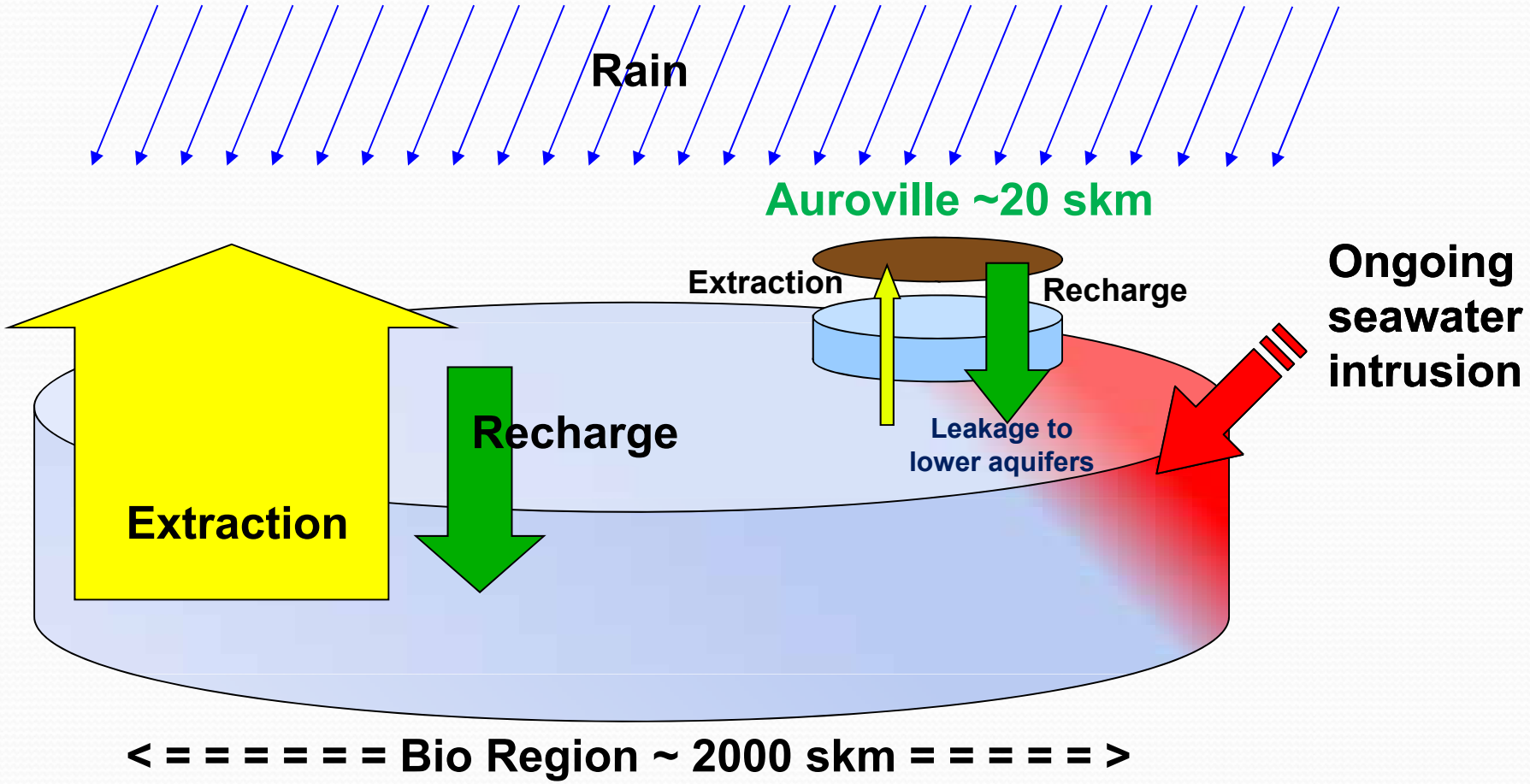
…

Auroville Context

50 years of Water Conservation

Auroville Context

Water Security cannot be achieved anymore through groundwater alone

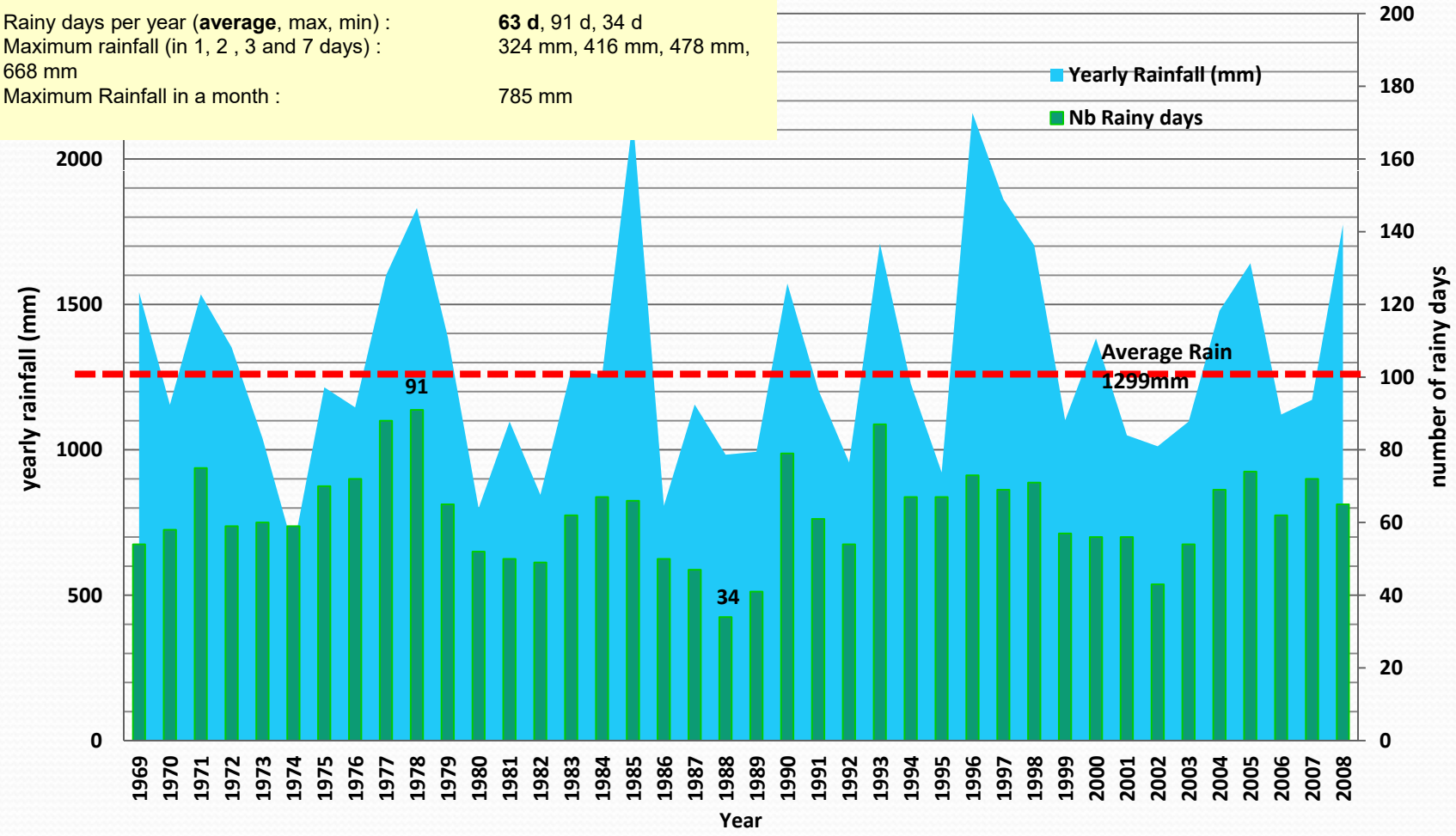


Rain

Yearly rainfall in Auroville area

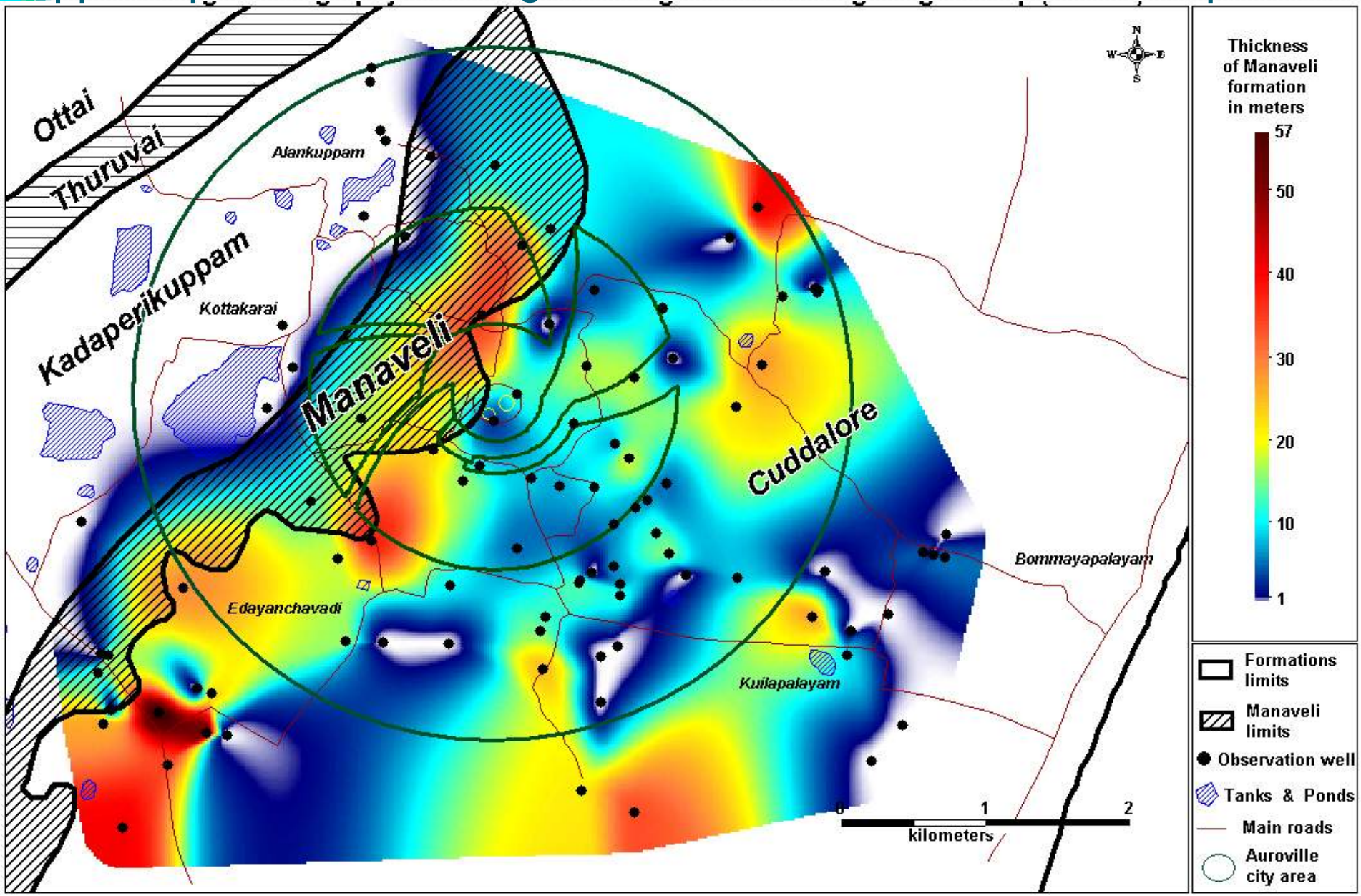
Source : Daily Rainfall in Pondicherry Meteo Station, Pondicherry Airport + Auroville Harvest Station

Period :	1969 - 2008
Average rainfall per year :	**1299 mm**
Maximum rainfall per year :	2159 mm
Minimum rainfall per year :	661 mm
Rainy days per year (**average**, max, min) :	**63 d**, 91 d, 34 d
Maximum rainfall (in 1, 2 , 3 and 7 days) :	324 mm, 416 mm, 478 mm, 668 mm
Maximum Rainfall in a month :	785 mm



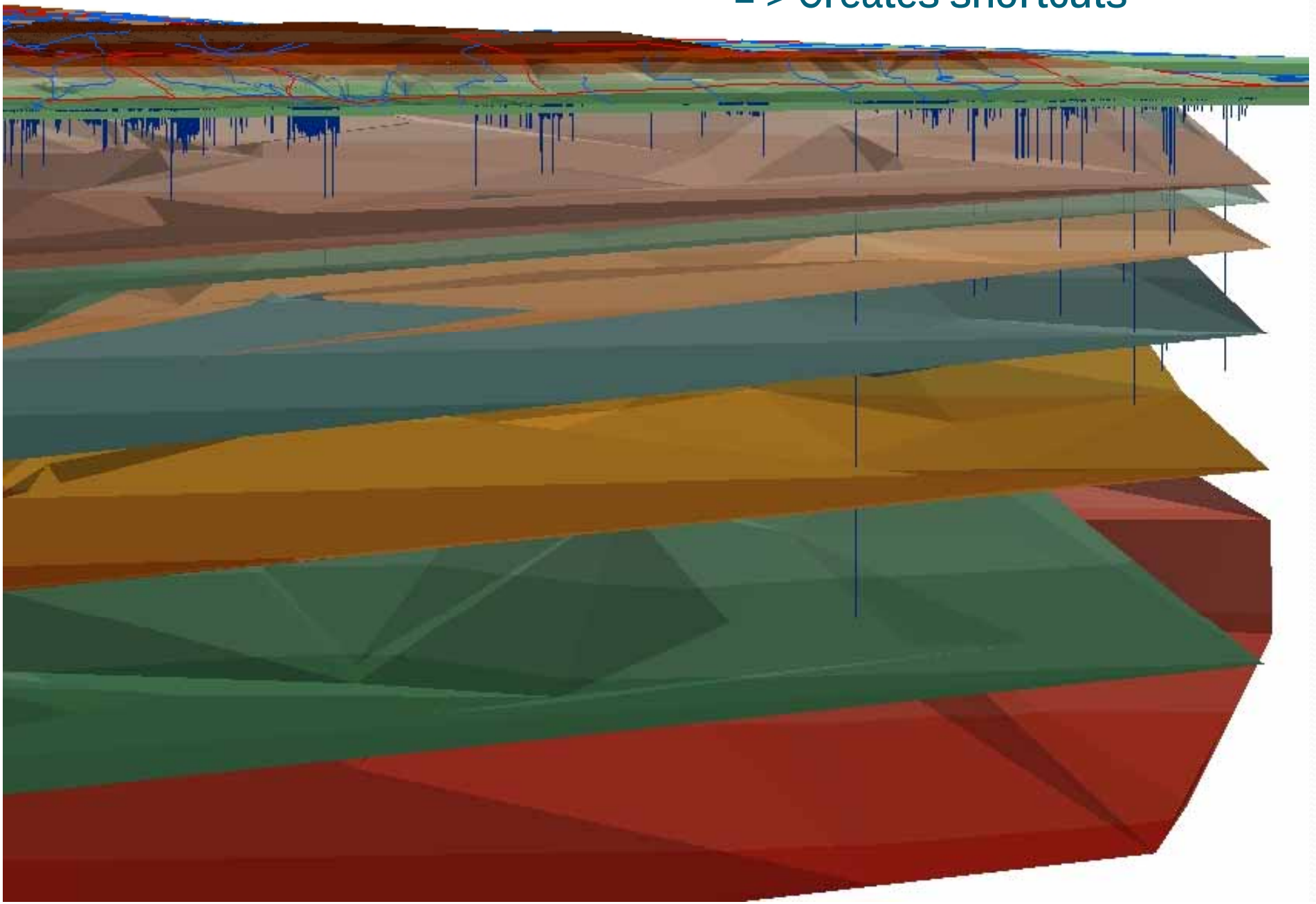
Groundwater in Auroville

Upper aquifer not water tight => Interconnected to 2nd & 3rd Aquifer

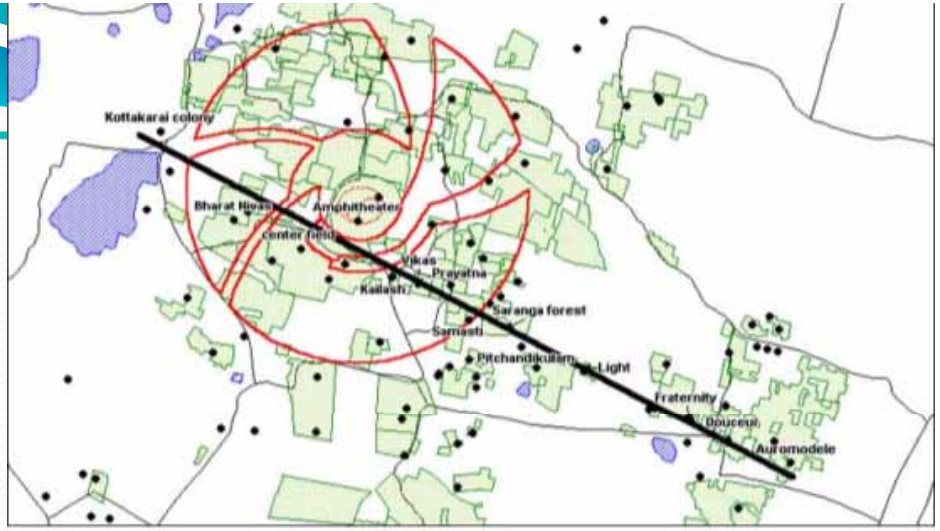


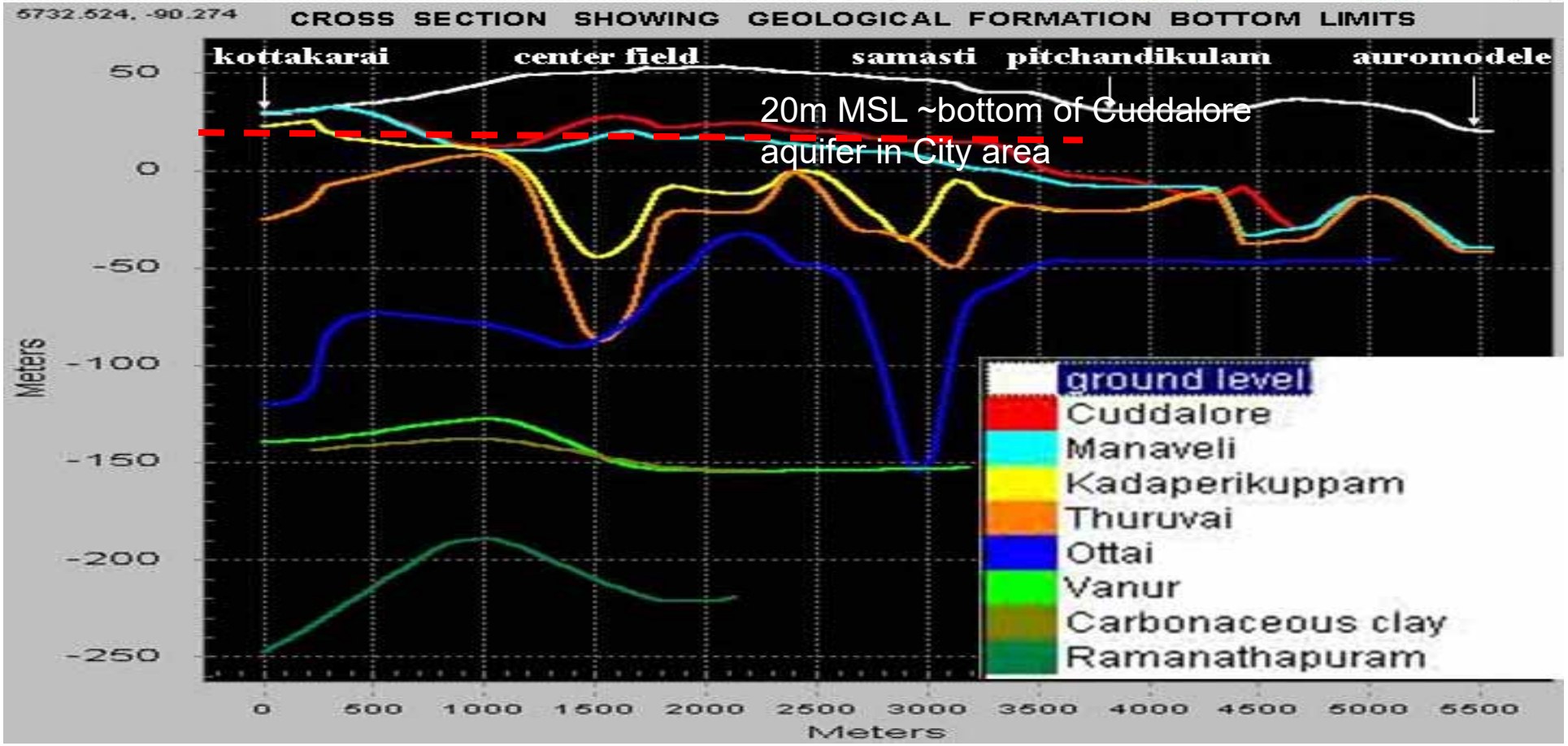
Groundwater

Wells tap multiple aquifer
= > Creates shortcuts



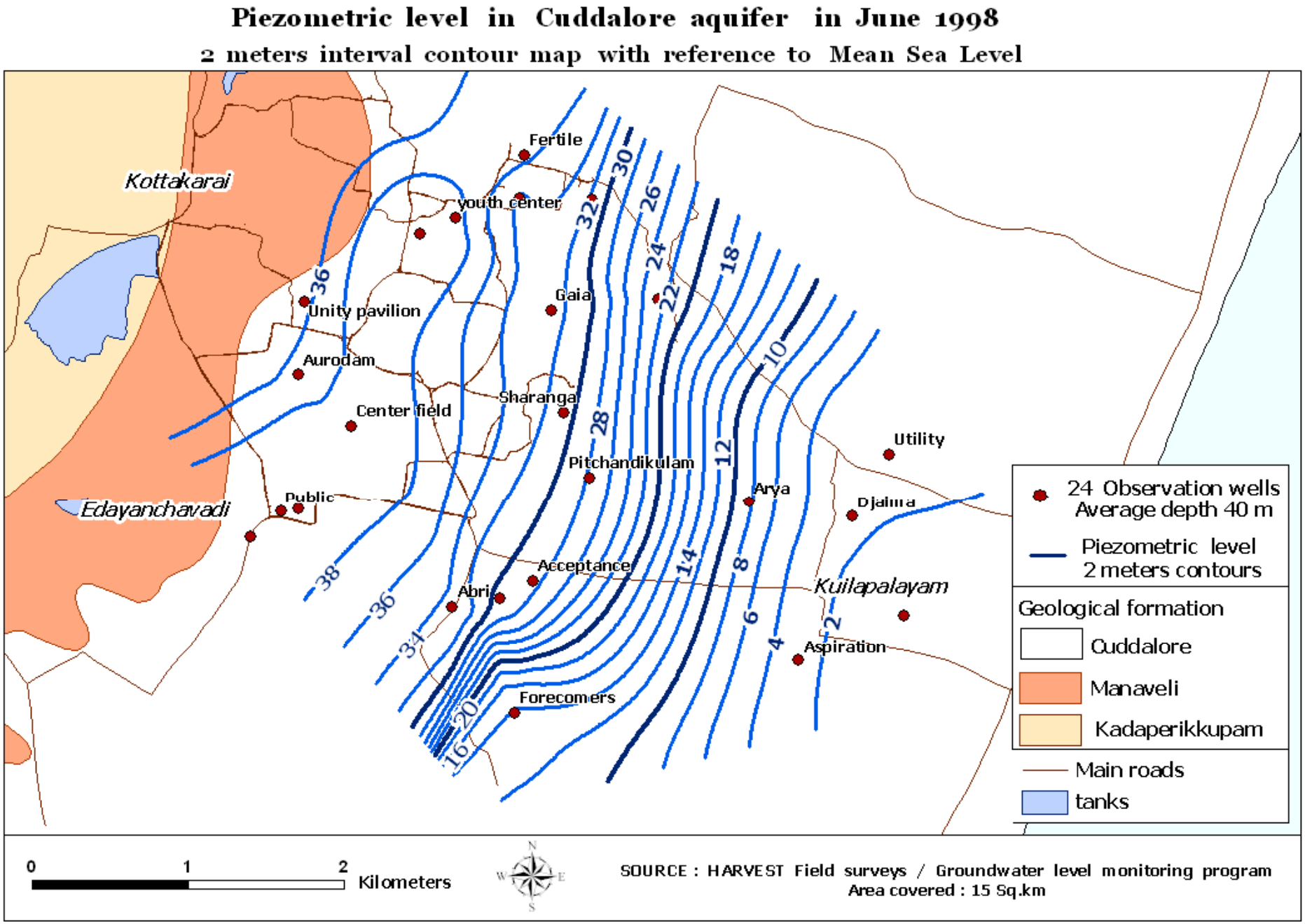
Ground Water Decline





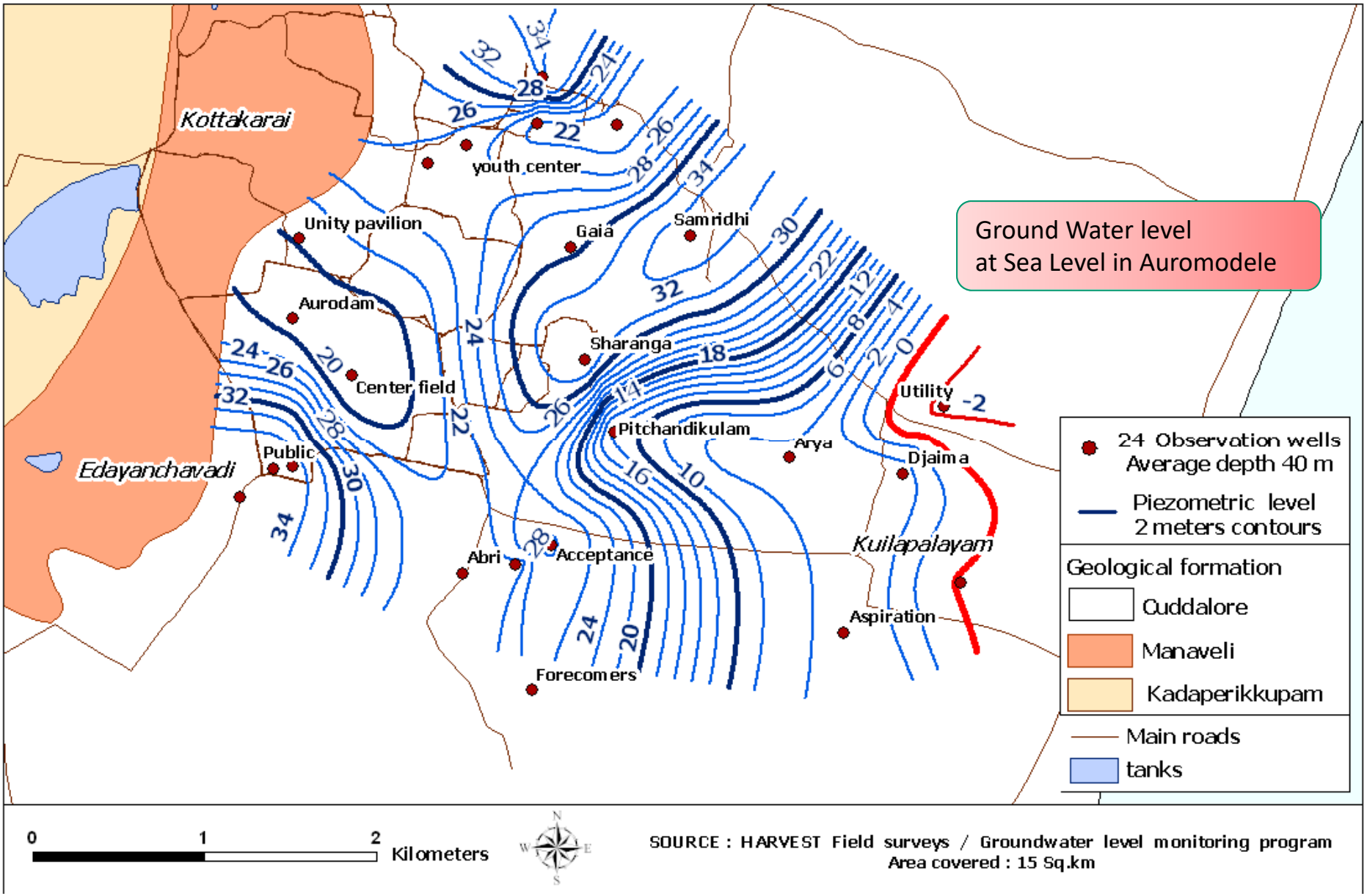
Groundwater decline

June 1998



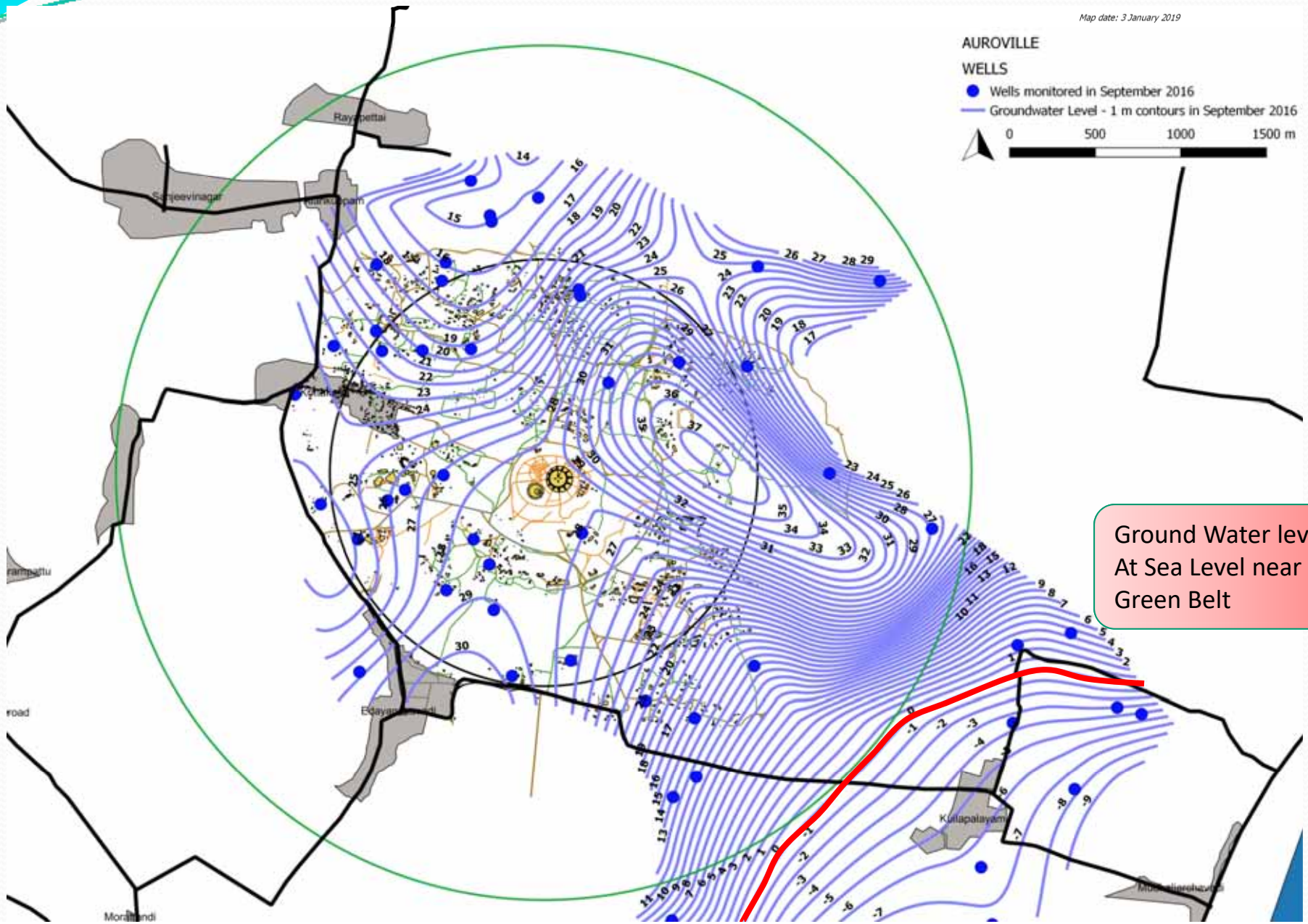
Groundwater decline

June 2004



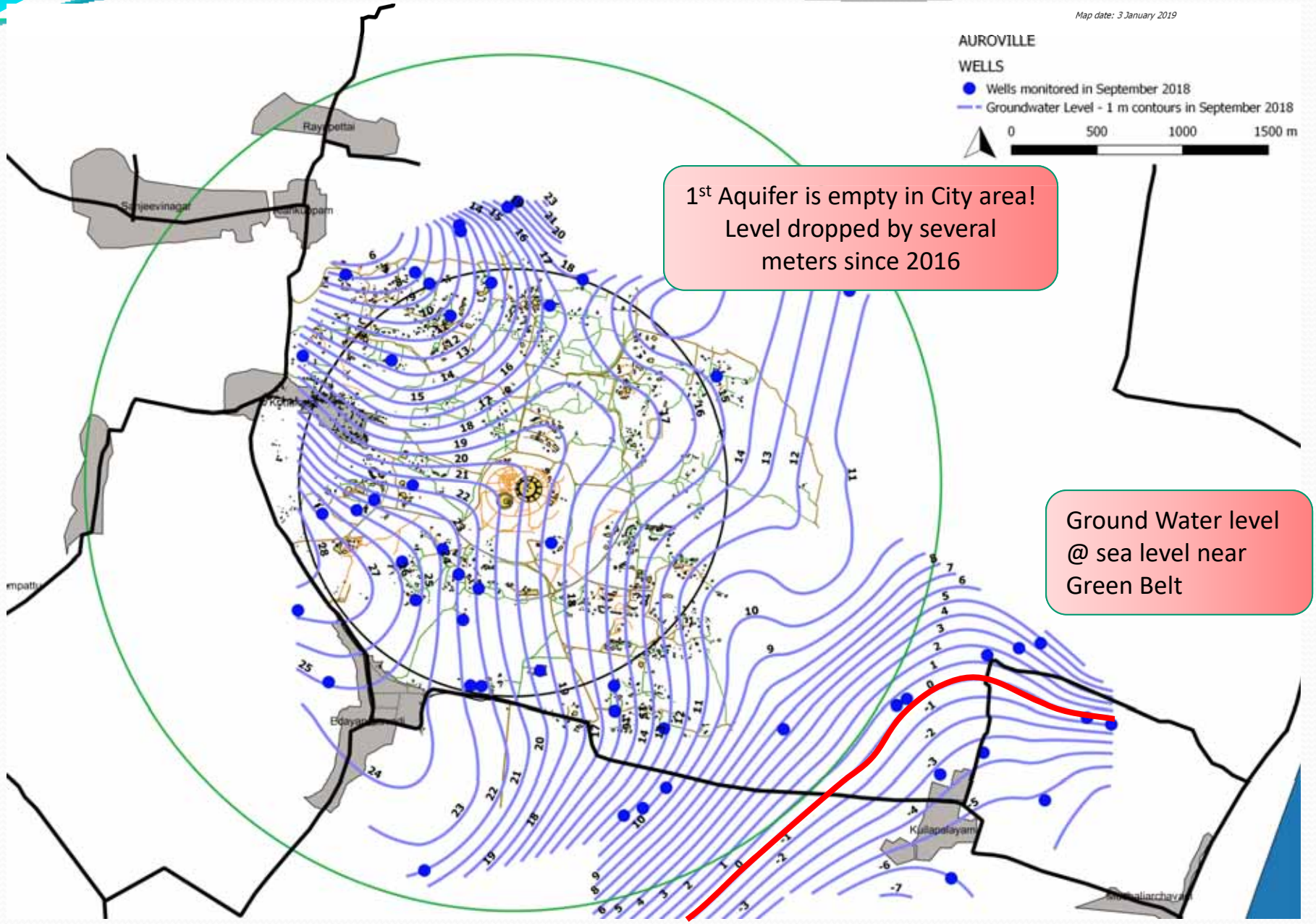
Groundwater decline

September 2016



Groundwater decline

September 2018



Auroville

Water Management: Way Forward

To Implement sustainable water management practices based on

Multi-sourcing	• Rainwater Harvesting & Storage as a top priority • Scalable
Recycling of treated wastewater	• First for greenery then in-house
Optimization of water consumption	• Metering • Water saving devices • Training of planners, architects & developers • Public awareness
Optimized supply networks	• For reliable accessibility

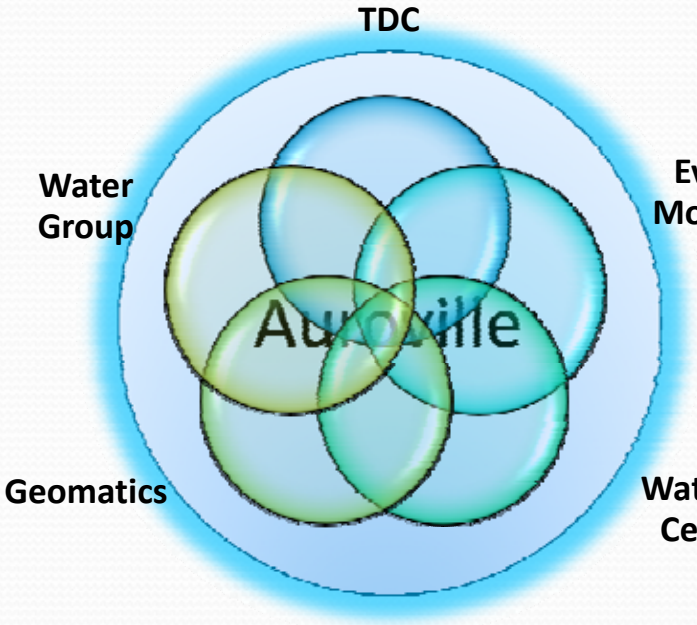
Auroville

Water Management: Way Forward

Protection of sensitive areas	• Forests • Water bodies • Sensitive eco-systems & Recharge areas
Monitoring	• Resources, Consumption, Quality •Open source data
Water Governance	• For a sustainable, informed, socially integrated water management
Capacity building for O&M	• Training, pear to pear etc
Funding	• Diversification of opportunity • Development of self-financing capacity
Dissemination	• Local population • Government • International agencies

Water Management in Auroville

Planning and Strategy



Linked
- Auroville Farms

Detached
- Matrimandir area
- Varuna

Service providers

Studies & Investigations	•**Geomatics Cell** •Agencies &individuals in and out of Auroville •Research organisations •Government agencies
Implementation O&M	•**Pour Tous Water** : Maintenance & Repair •**Road Service** : Earth work, installation of sewer and related systems. •**Water Service** : O&M & Installation of supply systems •**CSR** : design and provide solutions for STP and water storage •**Kireet** : implementation of RWH systems •**Alok** : O&M Auroshilpam supply system •**Auromodele Service Group**: O&M Auromodel supply system
Other implementing and O&M agencies	•AuroMira •Aquadyn •Selvam – Multipurpose Unit •Auzolan •Georgio (Water filter expert) • Outside agencies

Taking Stock

Main issues

- Total dependency on groundwater
  - Increasing number of wells turning dry during summer
  - Yield is decreasing everywhere
  - Few wells only offer good yield
  - Salinity is increasing along the coast and towards Kaluvelly
- Large scope for reduction of water consumption: recycling, reuse

Groundwater alone cannot ensure water security for Auroville

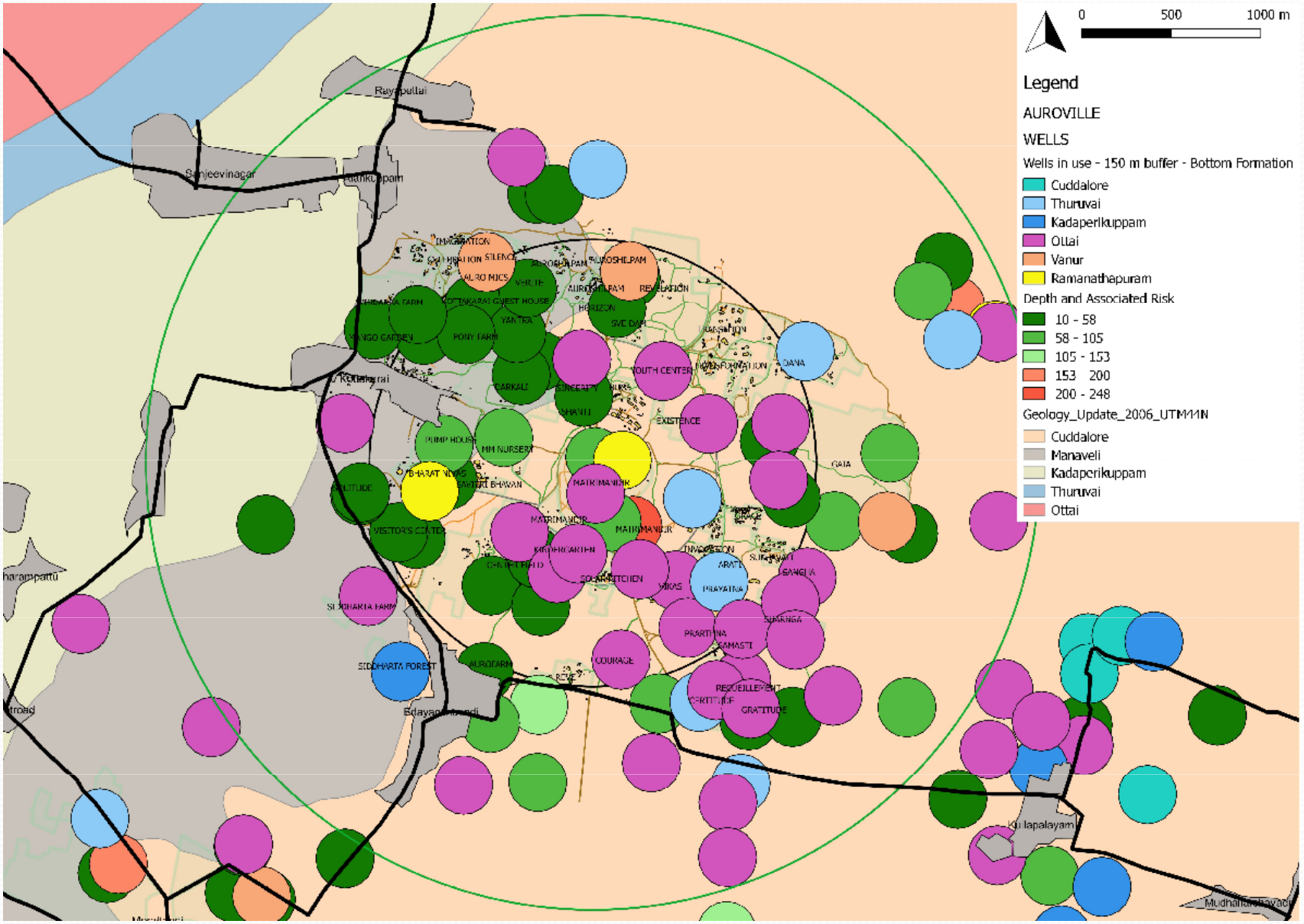
Solutions

- Multi-sourcing
  1. Rainwater harvesting: offers a very large untapped resource, will increase through development
  2. Groundwater: becomes a secondary resource, extraction has to be reinforced locally
  3. Recycling of wastewater to reduce fresh water consumption
  4. Promoting water saving in all fields of activities
  5. Metering
  6. Desalination of brackish or sea water as a last option

Taking Stock:

a. Water Sourcing – Ground Water

- 270 wells
- 176 wells are in use
- 18 wells feeding supply networks

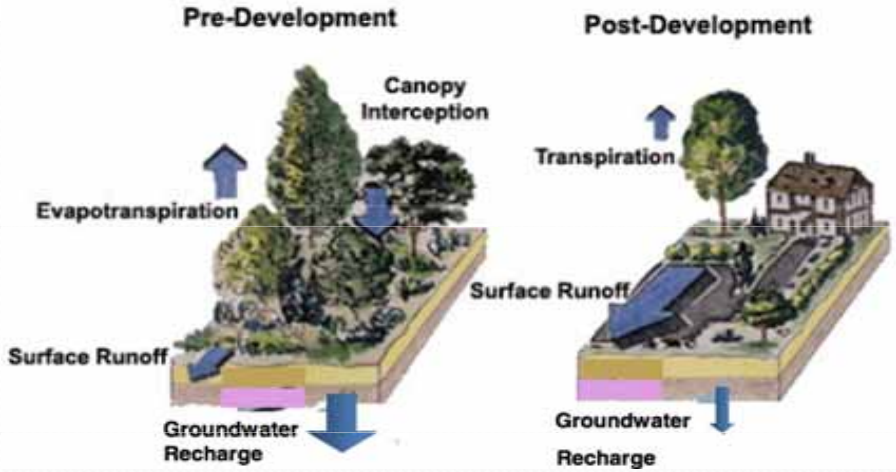


a. Water Sourcing

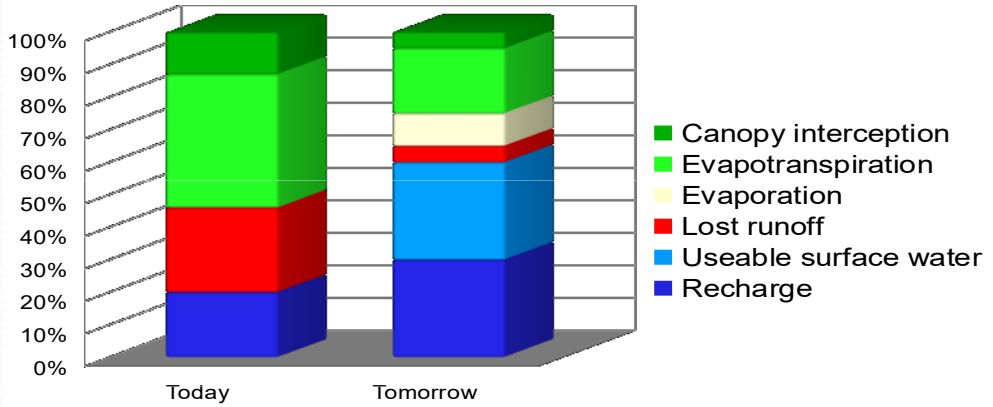
Rainwater Harvesting & Storage - Strategy

- Urban areas generate massive runoff
  - 400 to 500l/m2/y for Auroville area
  - **Rain Water Harvesting in Auroville City area can cover 70% of the demand on average year**.
- Perceived as a nuisance in urban area, runoff is our most precious resource
- ✓ We must start now!

Changes in water balance through urbanization



Scope for improved water balance through urbanization



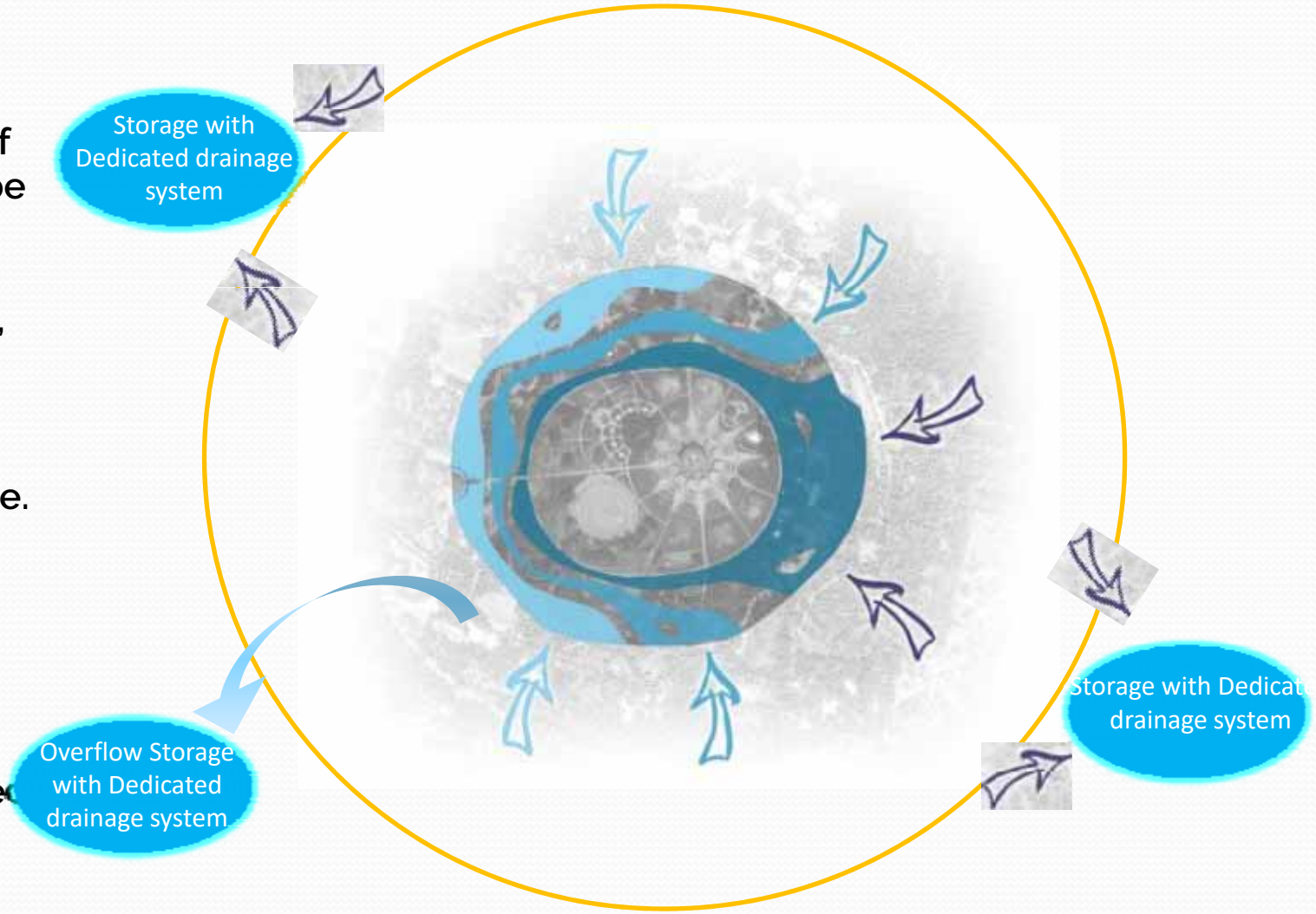
- ✓ The development of Urban bio swale and storage systems is an absolute priority
- ✓ Matrimandir Lake can and must be part of such system
- ✓ Such system will benefit the larger area by cascading effect

Ref: "Surface Water as a Resource for Auroville City Area, A study exploring a multi-sourcing approach for Auroville with the integration of Matrimandir Lake" -2012, presented to Governing Board, approved by Dr. Doshi, Chairman of TDC

Rain Water Harvesting as a resource

In Urban Area

- Other parts of the city can be drained to separate water bodies, ensuring water supply for the final 50,000 people.
- A modular design of the drainage and storage system is recommende
.



Rain Water Harvesting as a resource

Integration of Matrimandir Lake

- Each terraced section of the lake can be fed by a dedicated drainage system, in accordance to the topography, overflowing to the terrace below.

- Matrimandir lake will generate at time very large overflow which can be collected in a secondary tank.

Taking Stock:

Survey & monitoring

Main issues

- Poor topographic data
- Groundwater level fluctuation and quality cannot be monitored adequately
- Water extraction & consumption ill metered
- Actual runoff generation unknown
- Data needs constant update for decision making process and crisis management

Solutions

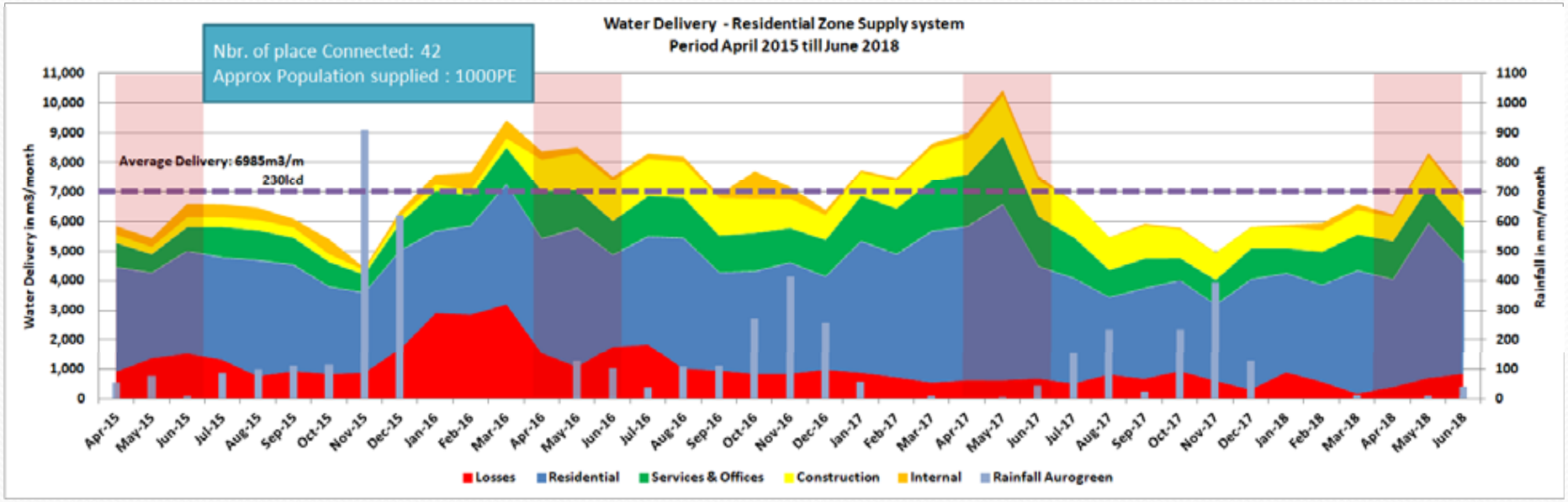
- Topographic survey: ongoing
- Drilling & equipment of aquifer-specific observation wells for monitoring of groundwater
- Connected meters on main distribution systems
- Installation of gauges on outlet points of micro-watersheds
- Installation of sensors on observations wells , data integration, map generation, open source

Taking Stock

a. Water Consumption

Estimated Water Consumption

- **Communities , Units & Services including green spaces:** Nbr of Residents: ~2850
  Total Person Equivalent: ~3800PE
  - Consumption: ~1000m3/d
- **Matrimandir area** including gardens, offices, facilities and Shanti
  - Consumption: ~200m3/d
- **Farms:** Nbr of farms 23
  - Buddha Garden: 5 acres cultivated, ~25m3/d = 1.2l/m2/d
  - Auro Orchard: 40 acres cultivated



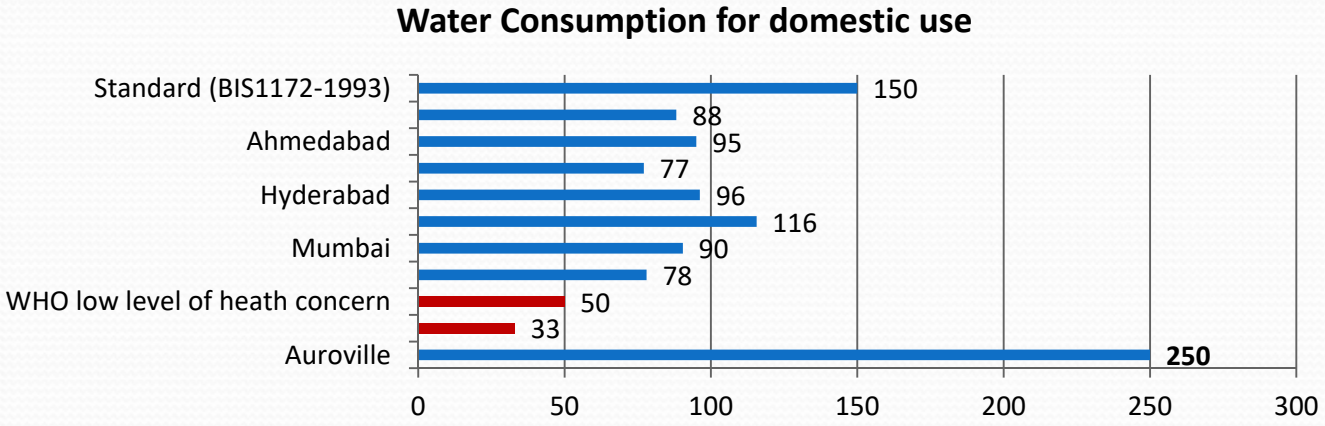
Taking Stock

Water Consumption

Main issues

- Metering not practiced in many communities = > consumption badly known
- Recycling of treated wastewater not common = > Fresh water over tapped
- Huge gaps of consumption between areas of Auroville
  - Based on Residential Zone system (~1000PE): av 230lpcd
  - Based on Auromodel system (~230PE): av 530lpcd
- Separation of Domestic Water/ Irrigation rarely done.
  - Optimized used often not possible today
  - Potential Reduction through wastewater recycling in RZ: 100lpcd

References

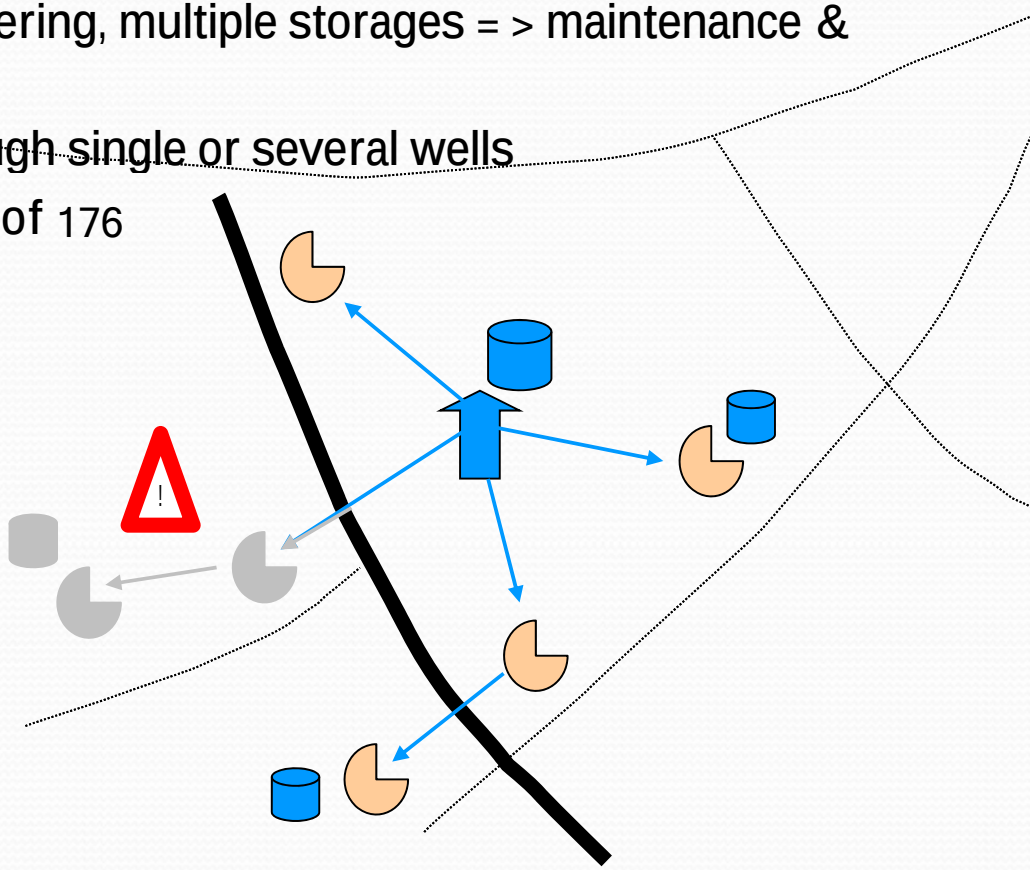


Taking Stock:
b. Water Supply

Present situation

- Ground water as a single resource = > no resilience
- Most water supplied by cluster by single wells = > no safety
- Networks in tree structure = > not optimal
- Aging networks, no maps, poor metering, multiple storages = > maintenance & quality control problematic
- 10 larger supply networks fed through single or several wells
- 18 wells used in large networks out of 176

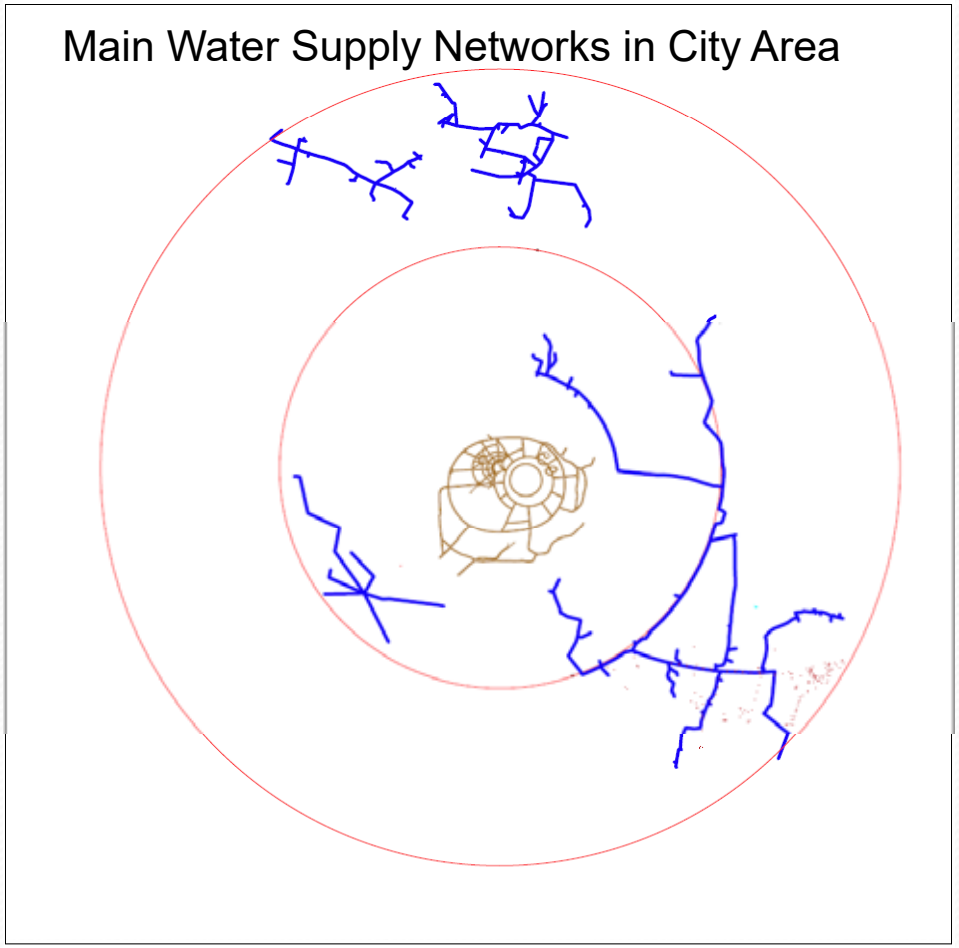
- **Main Drawback**
  - No or poor back-up
  - Poorly documented
  - Can lead to supply failure!



Water Supply

Present situation- Supply Networks

Main Network	Length of piping mts	Source of water	Connected Communities
RZ-Water Tower	~5065	5 BWs, all in RZ	42
Kindergarden Solar Kitchen	400	1 BW + 1 loose backup	10
Centre Field MT well	1340	1 BW	9
Courage	~1000	1 BW	7 + RZ Water Tower
Auroshilpam	2175	2 BW	11
Silence well	1200	1 BW	5
Kalabhumi	?	1 BW	5
Transition	?	1 BW	4
Aurelec – Fraternity-New Creation	~1200	3 BW	4
Auromodele	~2500	1 BW	9



Water Supply: Strategy

Securing Water Accessibility through sub-zonal supply network

Time frame: 2 years

1- Interconnection of bore wells at sub-zonal level

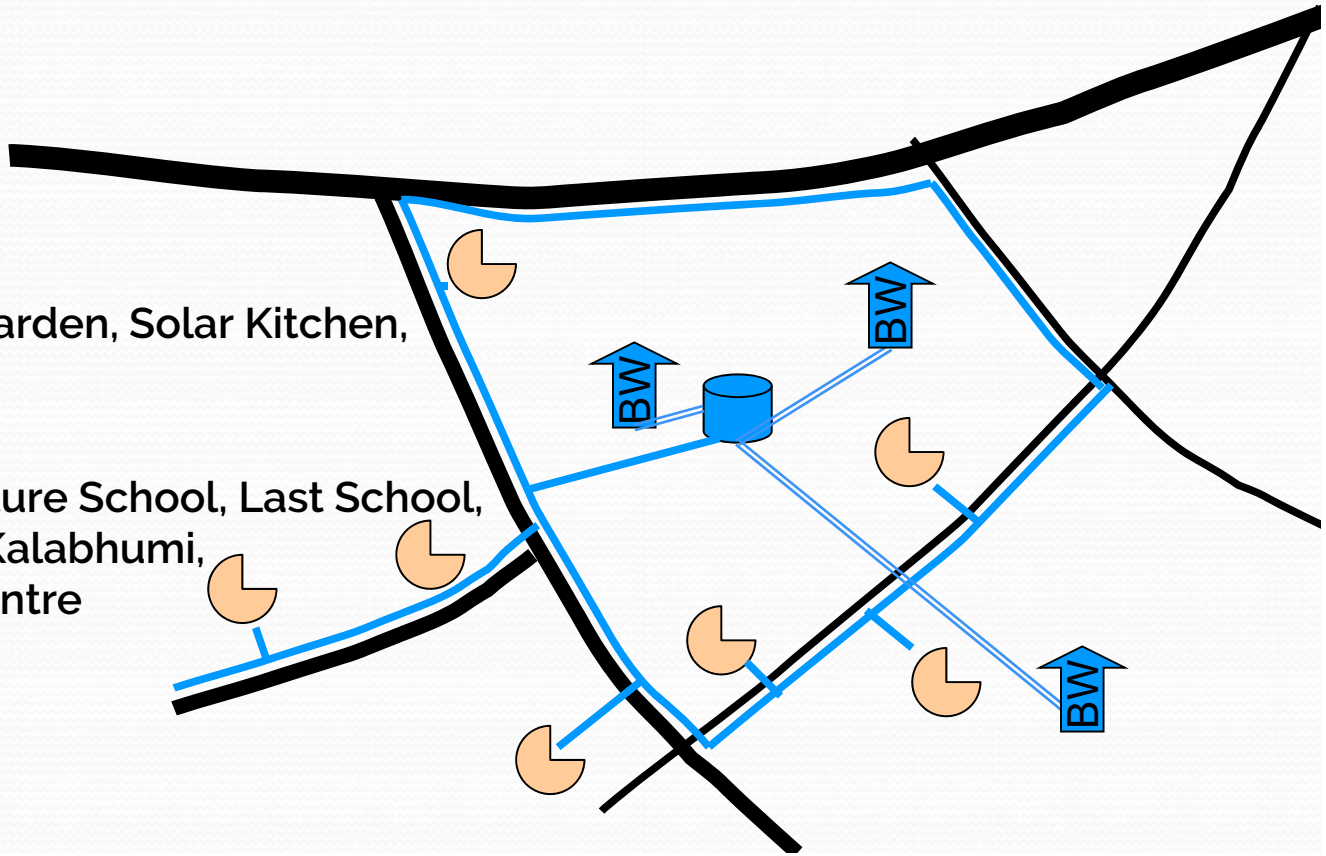
2- Common sumps at sub-zonal level

3- Development of supply networks at sub-zonal scale

- Loop networks type
- Connected metering

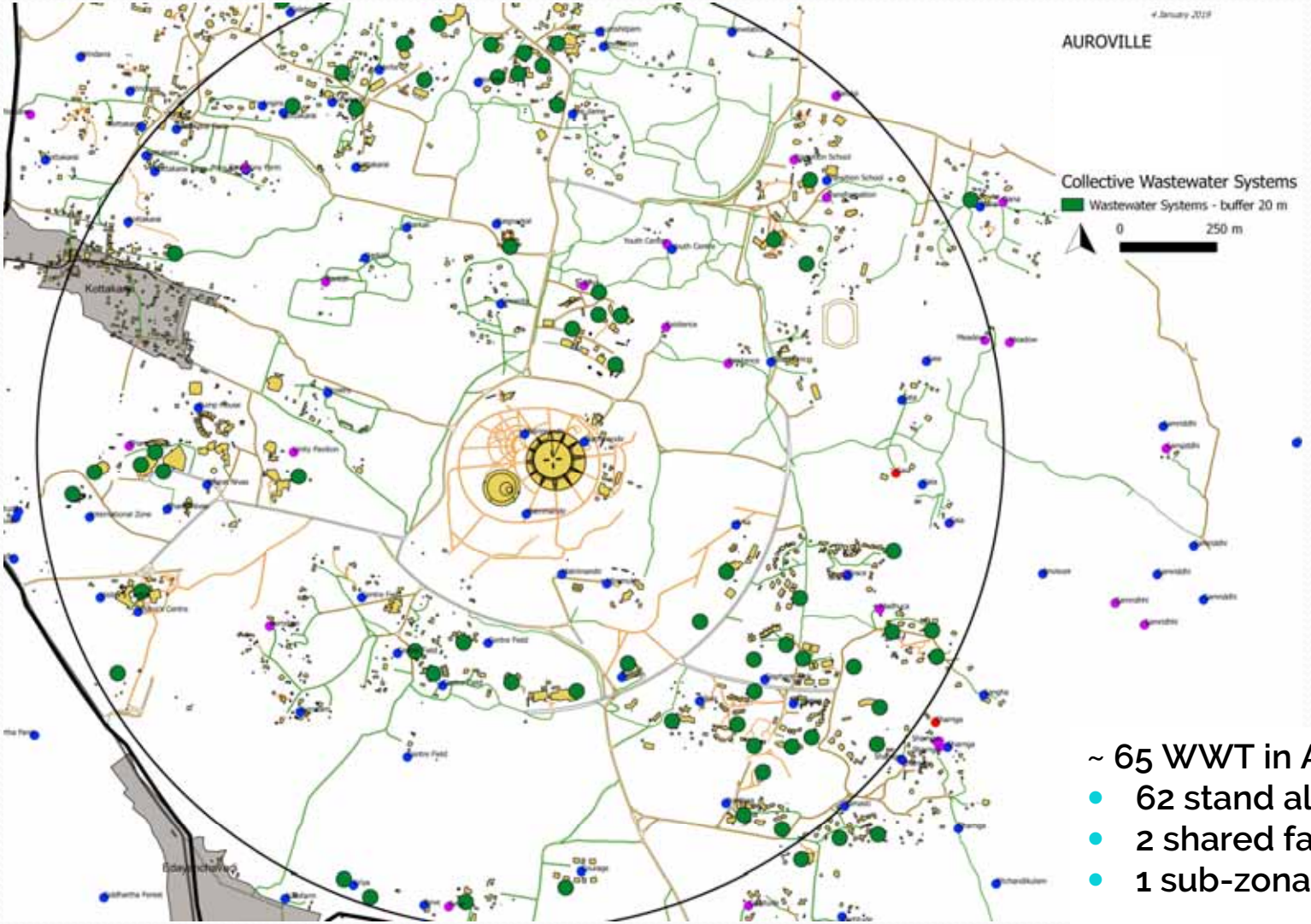
Prime Targeted Areas:

1. Residential Zone
   - Centre Field, Kindergarden, Solar Kitchen, Aurodam
2. Cultural Zone
   - Transition School, Future School, Last School, SAIIER staff quarter, Kalabhumi, Deha Shakti,Youth Centre
3. Service Area
4. Industrial Zone
5. Auromodele Area



Taking Stock:

c. Wastewater Management



~ 65 WWT in Auroville

- 62 stand alone
- 2 shared facilities
- 1 sub-zonal system

Wastewater management

Common infrastructure development in RZ

- Sewer: extendable to the full sector 1&2
- Prefabricated Modular STP. Actual capacity 60KLD
- Return line for irrigation recycling
- Can be upgraded to in-house recycling

Connected communities till date: 8

Ongoing 2019-20

- 60KLD extra on STP
- 8 Extra connected communities

Wastewater Management : Strategy

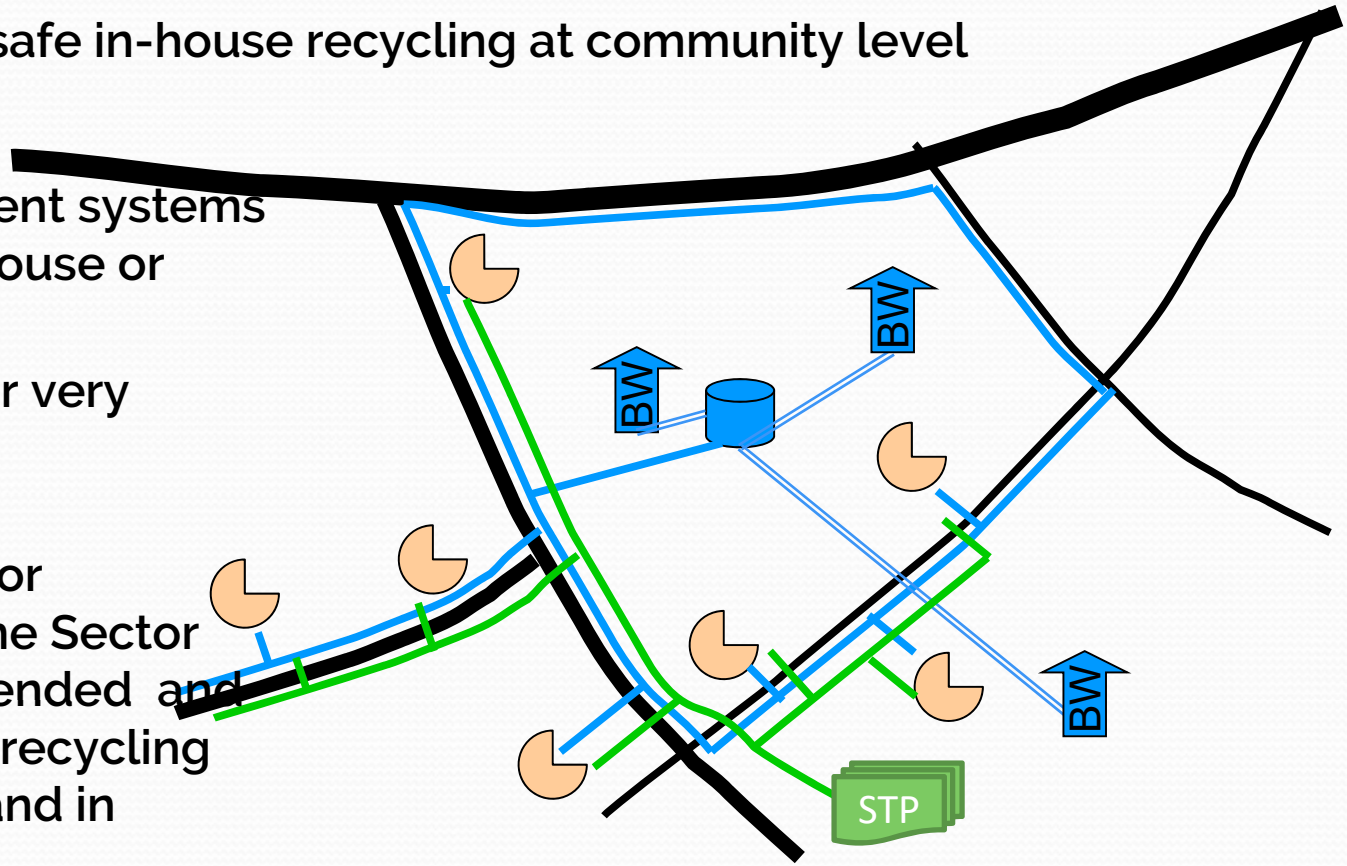
Reducing fresh water consumption through recycling of treated wastewater

Strategy

1. Development of collection and treatment facilities at sub-zonal scale
2. Access to recycled water for irrigation purpose
3. Provision for safe in-house recycling at community level

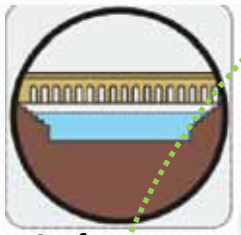
Actual situation

- Most of treatment systems are for single house or community
- Recycling so far very limited
- The common infrastructure for Residential Zone Sector 1&2 can be extended and allows for safe recycling for gardening and in Matrimandir

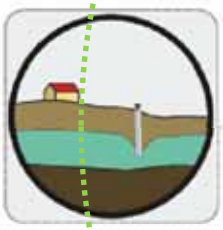


d. Multi-sourcing in Auroville

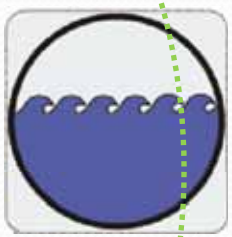
Integration



Surface water storage



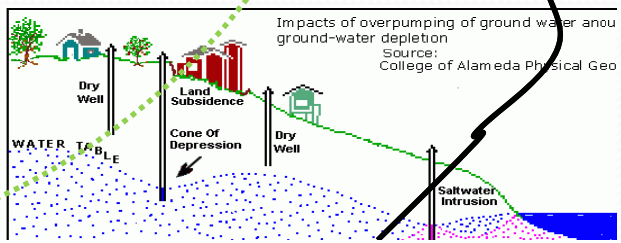
Groundwater Backup



Brackish groundwater desalination

Rain Water Harvesting

Reduce Recycle Reuse



Coastal line

Integration

Multi-sourcing in Auroville

- **Benefit:**
  - Water autonomy
  - Because of large green area groundwater is still recharged
  - The Water Balance is positive
  - The water footprint is equal to the city area
  - Direct benefit to the surrounding population
  - The same system can be extended downstream for a larger population

A similar approach fitting with local context can be reproduced in other cities of India

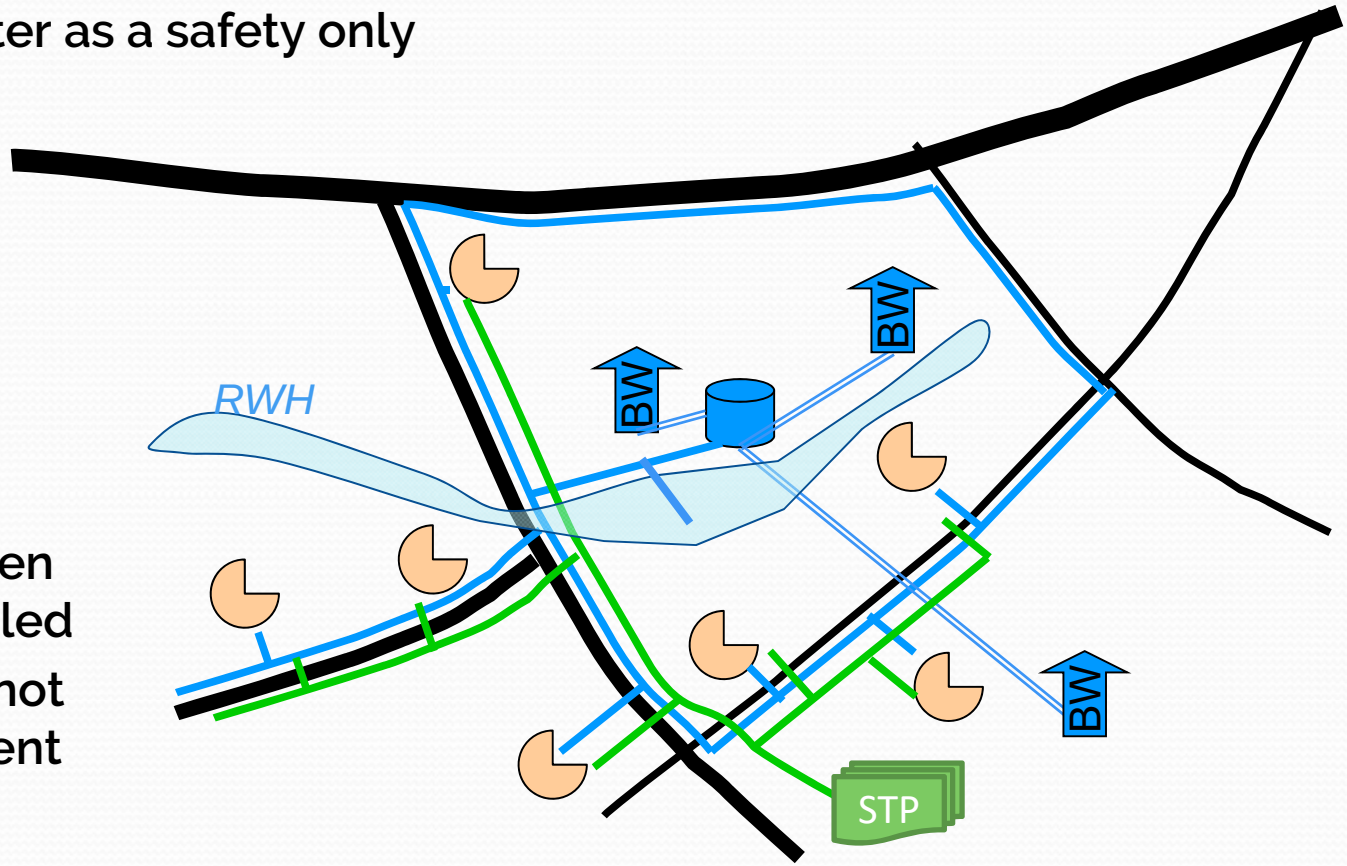
Multi-sourcing

Strategy

1. Development of urban swales, storm water storage, filtration , connection to supply system at sub-zonal scale
2. Access to recycled water for irrigation and in-house recycling
3. Groundwater as a secondary fresh water resource
4. Desalinated water as a safety only

Actual situation

- One single fresh water resource: groundwater
- Wastewater is often treated , not recycled
- Drainage system not integrated in present urban layout



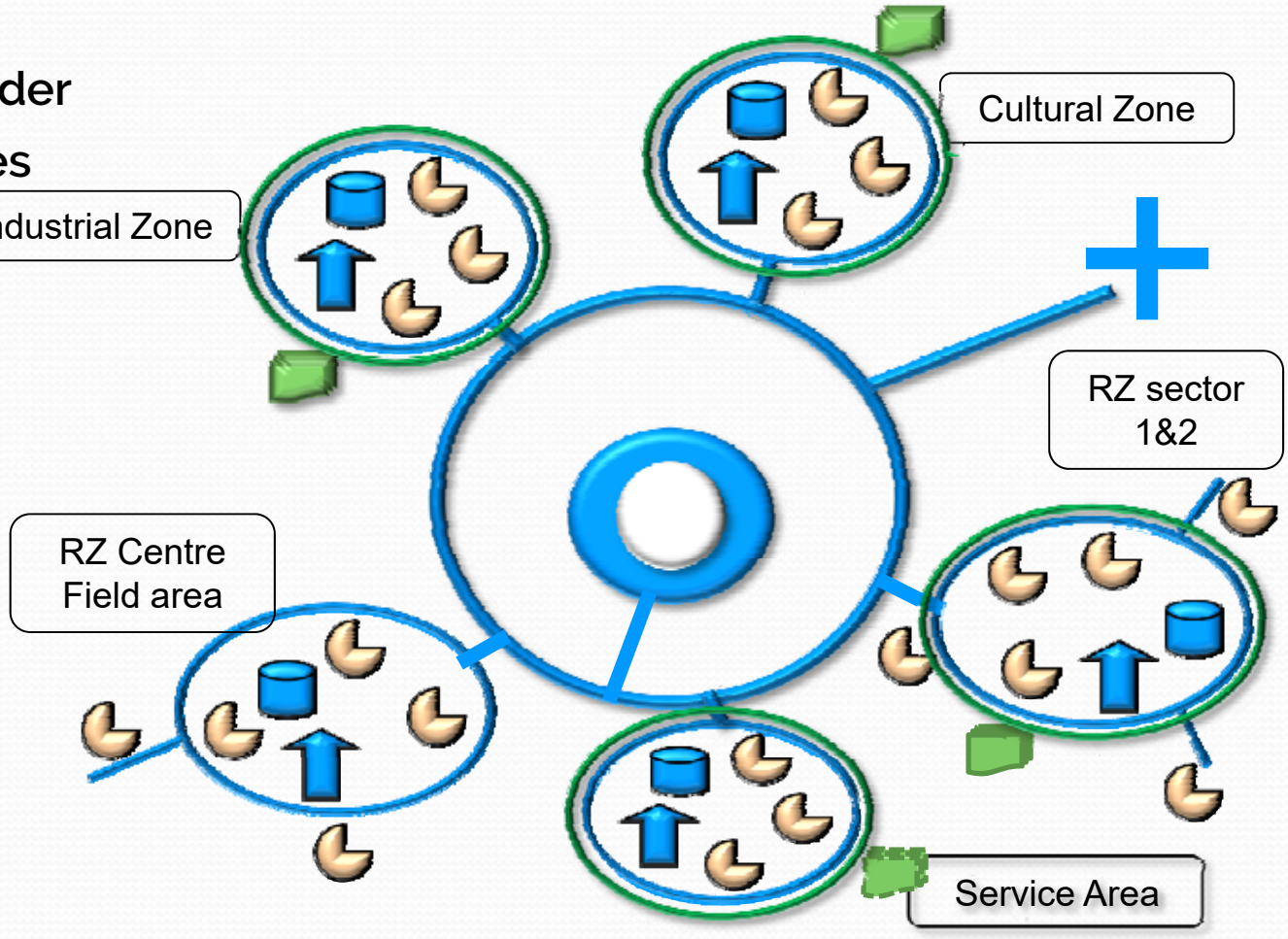
Multi-sourcing

Strategy

Extension to Zonal / City Scale

Time frame: 1st phase - 3 years

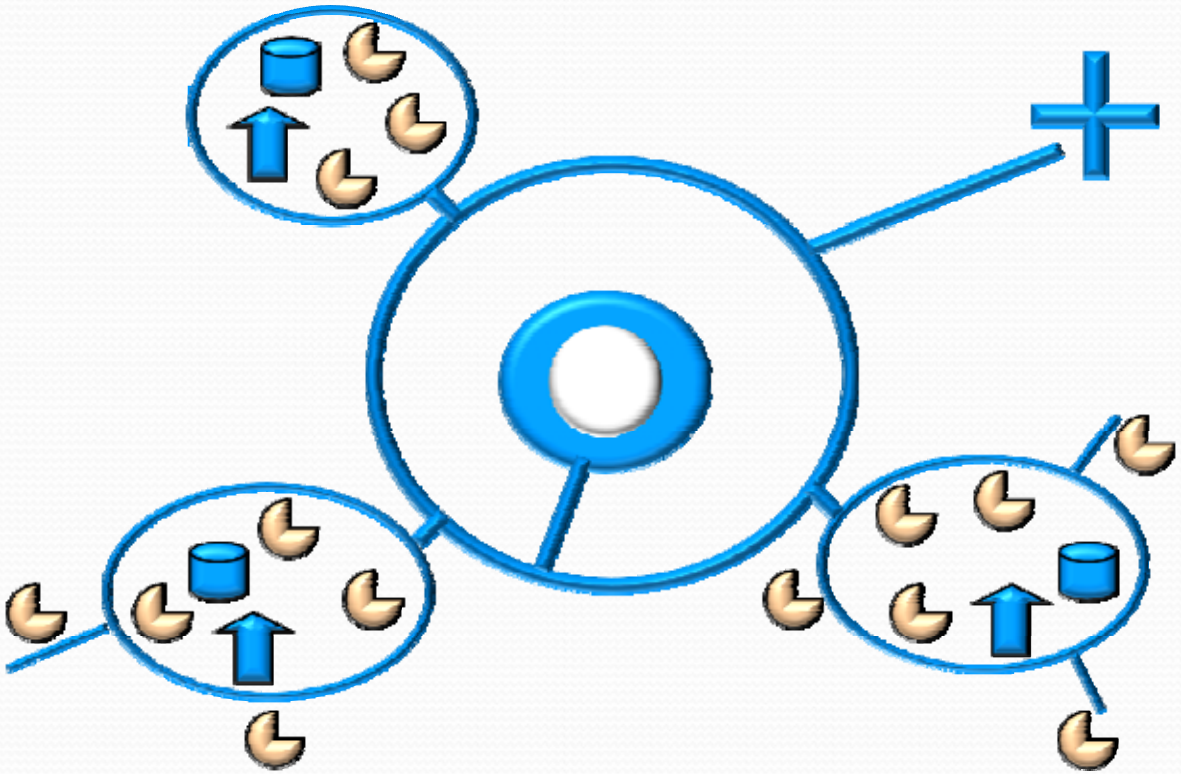
- Interconnectivity through a main feeder
- Sharing of resources
- Safer access to larger resources



Building up the resilience

The way forward

1. Surface water, Groundwater, Matrimandir lake, desalination…
2. Securing water accessibility
3. Benefitting the larger area



4. Requirements:

Rain Water Harvesting & Storage

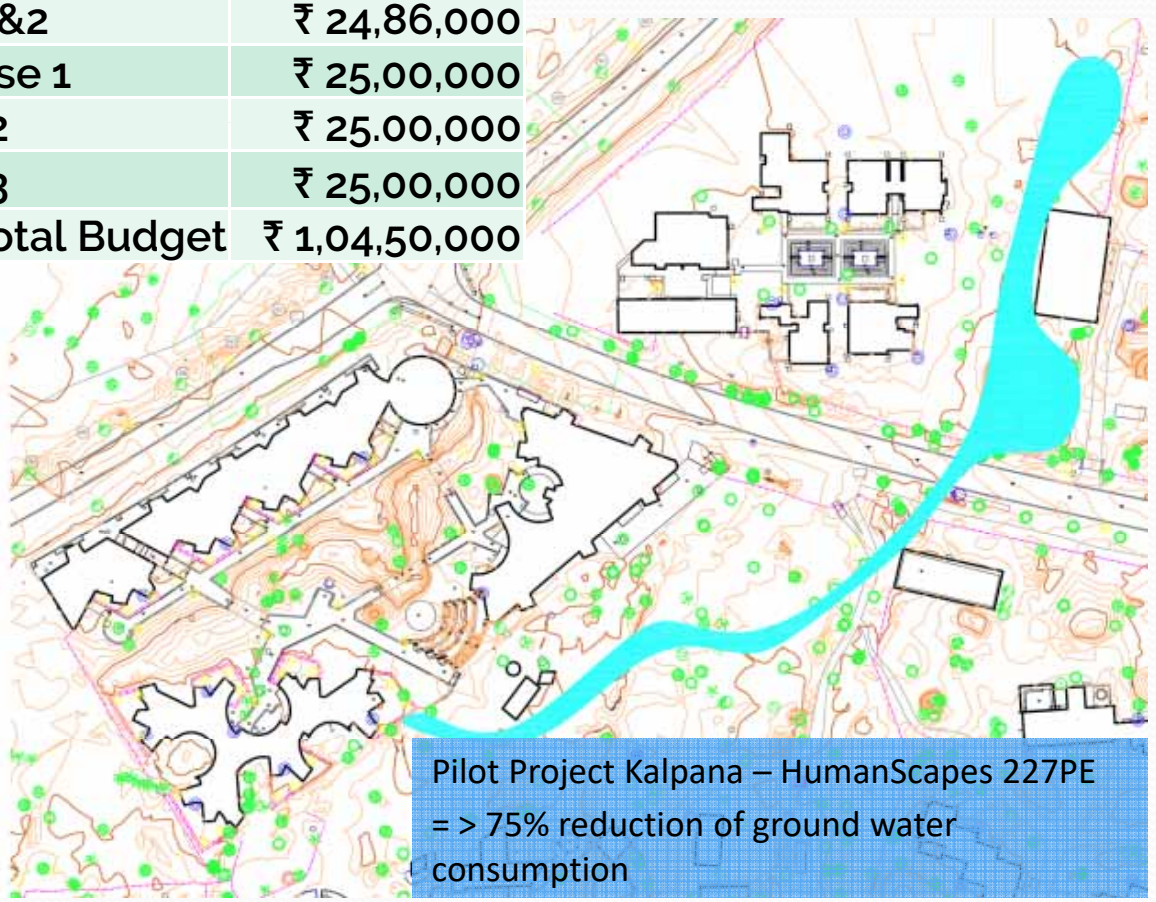
Phase 1: Urban integration in RZ Sector 1&2

Time frame: 2 years

RWH – Projects Short Listed		
2019-20	Pilot project RZ Sector 1&2	₹ 24,86,000
	RWH RZ Sector 1&2 phase 1	₹ 25,00,000
2020-21	RWH Sector 1&2 phase 2	₹ 25.00,000
	RWH Sector 1&2 phase 3	₹ 25,00,000
	Total Budget	₹ 1,04,50,000

Development of Rainwater Harvesting system at sub- zonal scale: Components

- Bio-swale integration in urban fabric
- Storage systems as part of the landscape
- Post treatment
- Connection to supply system



Pilot Project Kalpana – HumanScapes 227PE

= > 75% reduction of ground water consumption

Requirements

Water Sourcing - others

- In some areas water accessibility is unsafe
- Access to other sources will take time to be implemented
- Extra wells needed

Water Sourcing Others – Projects Short Listed		
2019-2020	Drilling and equipment of 1 well in RZ	3,75,100
	Drilling and equipment of 1 well in CZ	3,75,100
	Drillling and equipment of 1 Horizontal well in IntZ	5,45,600
	Total Budget	₹ 12,95,800

Requirements:

Water Supply & Accessibility

Water Supply – Projects Short Listed			
2019-20	Water Tower system	Filtration unit on 1 well in RZ	₹ 1,81,500
	Water Tower system	Connection of new RZ well to RZ supply system	₹ 3,53,100
2020-21	Water Tower system	Replacement of pipe lines from PVC to HDPE in RZ	₹ 5,91,800
	RZ Centre Field	Interconnection of wells in RZ - Centre Field area	₹ 4,77,400
	Cultural Zone	Interconnection of wells in CZ - Transition, Kalabhumi, Youth Centre	₹ 5,34,600
		Total Budget	**₹ 21,38,400**

Requirements:

Survey & monitoring

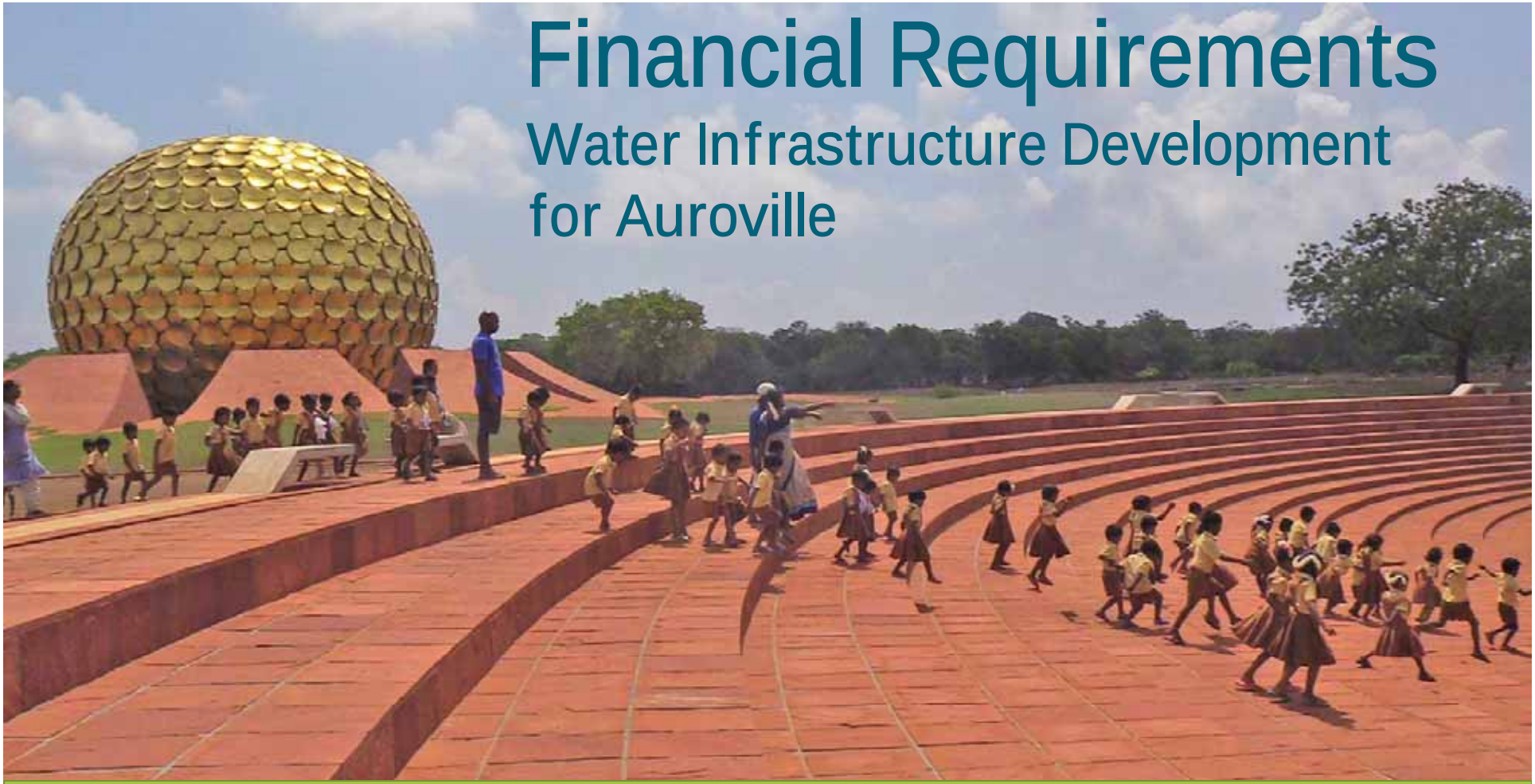
Strategy

- Drilling & equipment of aquifer-specific observation wells for monitoring of ground water
- Connected meters on main distribution systems
- Installation of gauges on outlet points of micro-watersheds
- Installation of sensors on observations wells
- data integration, map generation, open source
- Topographic Survey: on-going

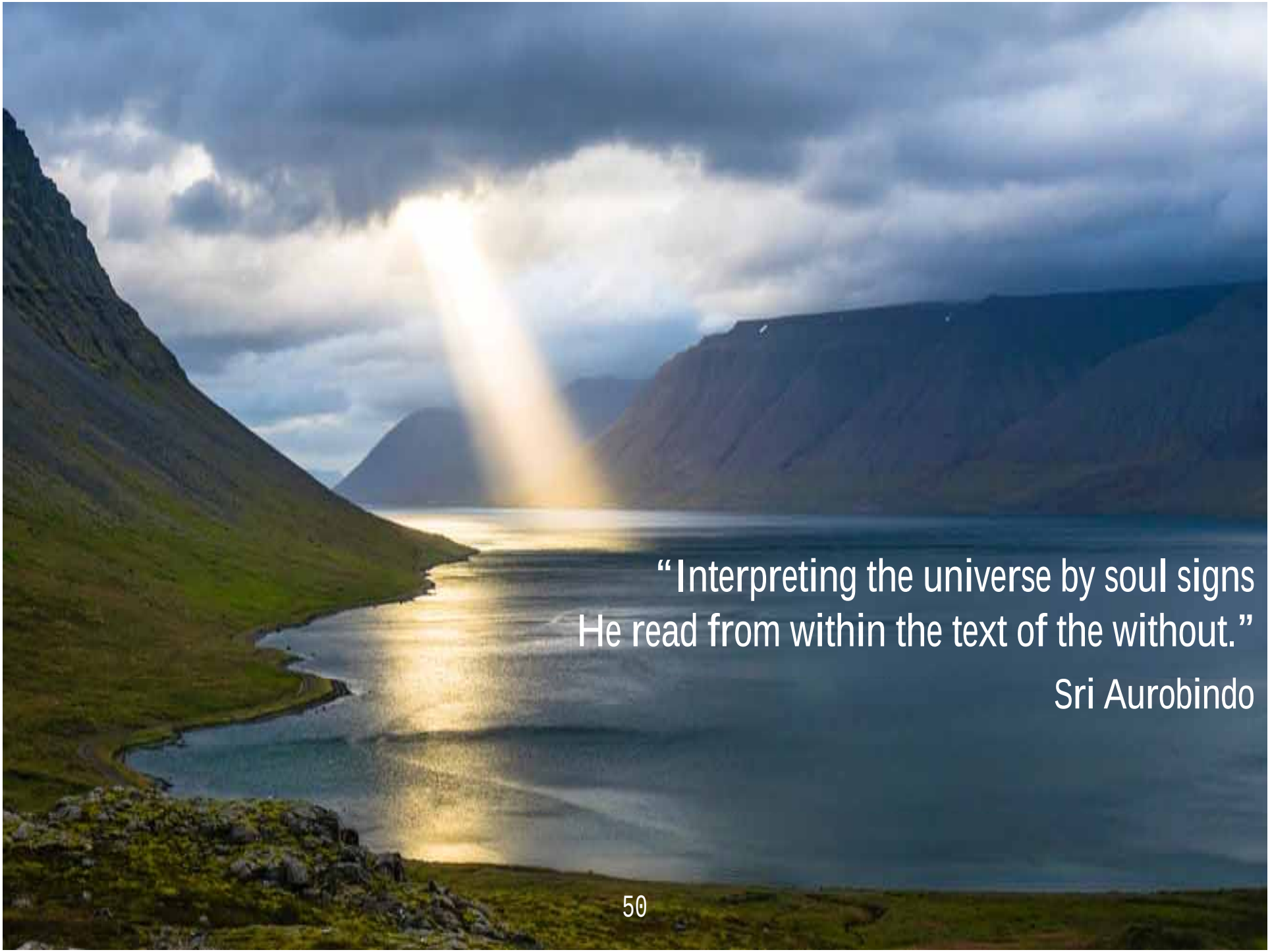
Survey & Monitoring - Projects Short Listed		
	Installation of 5 contactless connectable flow meters for wells and key part of supply systems	₹4,40,000
2019-20	Drilling and equipment of 4 observation wells in 1st aquifer monitoring, including installation of piezometer and transmitter	₹7,54,000
	Drilling and equipment of 4 observation wells in 2nd aquifer monitoring, including installation of piezometer and transmitter	₹9,46,000
2019-20	Installation of flow measuring device on Sukhavati check-dam	₹1,92,500
	Total Budget	₹23,32,500

Financial Requirements

Water Infrastructure Development for Auroville



Financial year 2019-2020		
	Indian Rupee	Euro
Monitoring & Metering	₹ 2,332,500	€ 30,323
Sourcing – RWH	₹ 10,450,000	€ 135,850
Sourcing - Other sources	₹ 1,295,800	€ 16,845
Supply	₹ 2,138,400	€ 27,799
TOTAL	**₹ 16,216,700**	**€ 210,817**


“Interpreting the universe by soul signs
He read from within the text of the without.”
Sri Aurobindo