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Towards Sustainable Water SDG6 Practices in Auroville
Study report

DRAFT Version, June 2021,
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Content

I. INTRODUCTION

We are in crisis and change is needed to avoid the catastrophe. In 2015, the UN compiled 17 goals and 169 sub-goals which point to the most urgent issues where change is needed to ensure the future of humanity. The SDGs, short for Sustainable Development Goals, are signed by 193 countries and aimed to be achieved by 2030. It is a utopian vision of a world where humanity can live sustainably.

But this is not the first crisis, which humanity has gone through. Throughout history, we can see the reoccurrence of such crisis. In crisis situations Intentional Communities' (ICs) movements have always intensified. In such communities, a small group of people, who perceived the crisis early, separated from the rest of the population and broke away from the mainstream. Members of the ICs worked to bring about the changes needed for human survival, first within their own community and then as a model for all of humanity. Their experiments were the foundations of humanity's evolution through paradigm shifts and regime changes.

After the 1960s, the first sensors of the present crisis formulated new types of ICs, ones that focus on sustainability. The voluntary mission of these ICs was to create the utopian world that is today described by the SDGs. People living in these communities combined ancient wisdom with modern technology and developed good practices. The immediate dissemination of such practical solutions is needed to tackle the global crisis.

To live in an IC comes with resignations and responsibilities that very few take on. ICs members oppose the mainstream world and create a new pattern of human life, a model for sustainability. Experiencing all problems of the current crisis but developing new solutions through prototyping, experimenting, and exploring sustainability. Not everyone is expected to live in ICs, but it is important that every region has ICs. These laboratories of sustainability increase the resilience of the whole region.

Unfortunately, a significant proportion, 90%, of IC's initiatives fail due to bureaucratic hurdles, and in competition with unsustainable organizations. Every region should have an economic- socio-political environment, where ICs reach their full potential and carry out their mission. Regional Governments (RegGovs) should recognize the importance of ICs which create sustainable patterns that can facilitate change throughout the region turning the crisis into a learning opportunity instead of a catastrophe. SDGs are a suitable tool for governments to assist the ICs. Unfortunately, neither ICs nor RegGovs have enough knowledge and expertise to localize the SDGs.

The slogan of SDGs is: "Transforming the world, and leaving no one behind!" Takács Sánta, an advocate for sustainability transformation through ICs, suggests four directions in response to the crisis. The top-down approach is the arena of governments and global institutions, the bottom-up is where small communities take the lead and the horizontal approach consists of the field of shared information, attitude change, and the formulation and establishment, of new social values and norms.

The literature review sought answers on how the current crisis developed and what methods are suggested to deal with the crisis systematically. I place particular emphasis on government crisis management as a top-down approach through the framework of SDGs. I describe in detail the opportunities and difficulties inherent in SDGs. I focus on SDG monitoring which is a vital element in achieving the desired changes. In addition, I introduced the ICs movement, their operation, history, mission, and challenges. I explored in the literature how SDGs are meant to be localized and monitored in ICs.

In my research process, I decided to focalize the work, as the 17 SDGs' research field was too broad and vague. The 6th SDG is fundamental to all other SDGs (Figure 1). The goal addresses diverse aspects of water through 8 targets to create a life where water is equitable and sustainable for present and future generations.

The 4th hypothesis (H4), **Auroille perform well the eight targets of SDG6,** formulated the following questions:

1. How does Auroville meet SDG6 and perform the eight targets?
2. Are all targets and their normative interpretations relevant to Auroville?
3. Which additional SDG6-related targets are addressed in Auroville?

Relevant literature on SDG6 and its localization was reviewed. Field research was conducted, including site visits, interviews, local engagement, focus group discussions, data and document collection and analysis. Laboratory analysis was done. The collected data were presented in the community forums, and the reflections were included in the conclusions.

Auroville has done and is doing exemplary landscape rehabilitation work, and its practices contribute to SDG 6 locally and globally. It is desirable to upscale these practices to regional, national, or global levels. The SDG framework can be used to bring the attention of decision- makers, policymakers, and local and global stakeholders to the researched communities' extraordinary achievements and good practices. This aspiration brought a new dilemma, how to share this idea?

With the support of Stichin de Zaiier and Serena's Eye film crew, a movie was made on Auroville's SDG6 good practices. The movie is to be shown to regional decision-makers to advocate for the inclusion of ICs in regional SDG6 actions and developments.

Link to the movie:

English version: https://www.youtube.com/watch?v=dteNLfkc0kA

Tamil version: https://www.youtube.com/watch?v=6uIluNdnQS0

II. LITERATURE REVIEW

II.1. Crisis and management

Even at the beginning of the 19th century, 97-98% of the human population lived in villages or nomadic communities (Ponting 1991), basically in communities. The generalization of "one-person groups" (Csányi 2002) is a product of mass urbanization starting in the 19th century and ending in the 20th and 21st centuries (Takács Sánta András et al 2017). Today half of humanity, more than 3.5 billion people lives in cities. While by 2014 more than 30% of urban populations in developing countries lived in slums, cities seem to attract more and more people in search of greater opportunities and a better life, 95% of the urban increase will be in developing countries (UN 2017)

The loss of community and its rediscovery was an important and widely discussed academic topic in the social and political academic publications of the 18th and 19th centuries. From the 19th century, there was an increased tendency to idealize the community and describe the pain of losing the traditions, stability, and collective memory. The problem of disintegrating communities grew with the emergence of an industrializing and highly mobilized society.

We lost not only the human community but also our belonging to nature. Edward o. Wilson in his Biophilia Hypothesis explains that regular relationship with nature and other species is essential to human mental health and well-being.

In 1962 Rachel Carson's book The Silent Spring, presented the uncontrollable technological advances and the harmful effects of chemicals used in agriculture. Many are counting the start of the global green movement from the publication of this book.

The risk of starvation and contaminated food has not disappeared with modernization, but new challenges have emerged: GMOs, preservatives, and chemicals.

Moral dilemmas in nutrition are also becoming increasingly important, such as animal rights, sustainability, producers' working conditions, livelihoods, the use of GMOs, and nanotechnology.

Not only the quantity of food but also the quality is becoming increasingly important, food chemicals, pharmaceutical content, preservation and storage chemicals. In the food industry dictated by global capitalism, eco-nutrition movements were established in the 20th and 21st centuries which link health concerns with the achievement of security, sustainability, equal rights, and democracy.

In 1898 Lucy Deane warned about the health risks of asbestos. One hundred years later in 1989, the UK government decided to ban white asbestos, and the EU followed this ban one year later. In the UK about 3000 asbestos-caused deaths occur every year, and in Western Europe, 250.000-400.000 asbestos cancer cases are expected in the next 35 years. The experience was the basis for the precautionary principle:

Ecosystems and managing the dynamics of change.

The dynamical behavior of the planet's natural systems is now changing more rapidly than at any time previously during the previous 10000 years of the Holocene. Evidence of the scale, magnitude, and significance of these changes has been sufficient for geologists to conclude that an epoch-scale boundary has been crossed and that we are now in a new epoch — the 'Anthropocene' (Steffen et al., 2011; Zalasiewicz et al., 2011). Living in the Anthropocene will require us to deal with ongoing and rapid or sudden onset threats such as oil spills, chemical and nuclear accidents, earthquakes, landslides, tsunamis, volcanic eruptions, severe weather, storms and cyclones, floods, wildfires and epidemics, and slow-onset threats such as air quality, droughts and desertification, food security and epidemics and climate variability (UNEP, 2012).

A network of theoreticians and mathematical ecologists began to expand their ideas on four major concepts of non-linear dynamical systems behavior: planetary boundaries (Rockström et al., 2009); tipping points or elements, (Lenton et al, 2008; Schellnhuber, 2009), panarchy and resilience (Holling, 1996; McGlade, 1999). Rockström and colleagues have proposed nine hard global biophysical limits, or planetary boundaries, for human development — land-use change, biodiversity loss, nitrogen and phosphorous levels, freshwater use, ocean acidification, climate change, ozone depletion, aerosol loading, and chemical pollution. It is likely that the effects of the tipping elements described by Schellnhuber, Lenton, and co-workers, will come to define future surprises. We are experiencing some of them already — Arctic sea ice loss; boreal forest dieback; melting of Greenland ice sheet; instability of the west Antarctic ice sheet; Atlantic deep water formation and permafrost and tundra loss. Others are potentially yet to come — climatic change-induced ozone hole; greening of the Sahara; chaotic multi-stability of the Indian monsoon; changes in the amplitude or frequency of the ElNiño Southern Oscillation (ENSO); dieback of the Amazon rain forest; West African monsoon shift; and changes in Antarctic bottom water formation.

Buzz Holling, Brian Walker, Carl Folke, Terry Hughes, Steve Carpenter, and colleagues have been exploring socio-ecological systems around the world (www.resalliance.org). The idea has been to create an empirical and theoretical base on which to understand abrupt change in managed resources and to develop a general theory with heuristics and principles to better understand resilience (Holling, 1973; Gunderson and Holling, 2002; Walker et al., 2006). The concept of resilience in ecosystems was introduced by Holling in his classic paper on non-linear dynamic models that captured the relationship between stability and resilience in ecosystems (Holling, 1973). Whilst some ecologists considered resilience to be a measure of how quickly a system returns to an equilibrium state after a disturbance (what is now known as engineering resilience), Holling kept to the notion that ecological resilience was the measure of how far an ecosystem could be perturbed without experiencing a regime shift (Hogg et al., 1989; Holling, 1996; McGlade, 1999).

In most instances, the dynamics of the adaptive cycles are the product of the interlinkages between the ecosystem and people, and it is generally these, sometimes hidden, cycles that managers are actually coping with.

Crisis management response possibilities.

In his 1968 work Tragedy of Commons, HARDIN outlined a null model of the ecological crisis. Many see the crisis as unavoidable, but we can still avoid the tragedy. Ostrom (Takács Sánta 2017), suggests change by synthesizing the results of several disciplines.

Sustainability is complex and unknown. He suggests analyzing transitions for sustainability. His concept gives credit to bottom-up initiatives ICs, and even emphasizes that transformation is unattainable without them, but also states that the involvement and support of a socio-technical regime is also vital for structural change.

The lobbying of cohesive local communities can be key to regaining people's power over their lives, that is, making democracy more participatory. Changing the top-down system is the self-determination of local communities and the strengthening of local governments are essential conditions for sustainability.

Takács in his book Comedy of Commons, writes about the rediscovery of communities and shows four possible response models to Hardin's sustainability dilemma based on the work of Gardner and Stern (2002) and Ophuls (1973, 1977). 1: Through laws, regulations, and support mechanisms created by the government in top-down systems, 2: By initiating community-led, non-governmental social processes, 3: By disseminating knowledge and causing attitude shifts, 4: By changing values, norms, and worldviews. In my research, I combine these responses.

My work contributes to all 4 response models. At the top-down government level, I use the SDG framework along which the work of governments is influenced. The bottom-up level is Auroville who locally manifests the SDGs through prototyping, experimentation, and learning from failure, and the movie contributes to the worldview change.

Rapid and profound change can be achieved within the ICs, but more tools are required to impact the external reality and reach the mainstream. I handle responses 3 and 4 together and call them the horizontal plane, where I offer tools, that can enhance collaboration between top-down and bottom-up approaches and impact the mainstream. I compiled an SDG6 monitoring collection, the SDG6 localizing workshop, and an educational video on SDG6 in Auroville.

II.2. SDGs a Top-Down Response

The UN has been working since the seventies to advocate sustainable development. In 1972 the UN held its very first conference on the Environment in Stockholm. In 1987 the Brundtland Commission published "Our Common Future" calling for sustainable development. In the 1992 UN Earth Summit in Rio de Janeiro, the Agenda 21 is created. Five years later in 1997, the New York UN Earth Summit +5 launched a new global partnership for sustainable development. In 2002 the UN World Summit on Sustainable Development in Johannesburg committed to the Millennium Development Goals.

In 2012, at the RIO+ 20 conference, it was decided to learn from the Millennium Development Goals and create a new program that applies to all nations and encompasses the whole concept of sustainability; with its environmental, economic, social, and human aspects. The new Sustainable Development Goals or SDGs framework has been developed over three years by the UN, with countless meetings and consultations involving hundreds of thousands of people and all sectors of society, including 5,000 NGOs. The new 2030 framework was adopted in September 2015 by 193 countries. SDG has 17 goals and 169 targets, and its primary mission is to transform our world by leaving no-one behind.

India has reshaped its national targets in line with the SDGs. It created the NITI AAyog program, which formulated the country's 3-, 7- and 15-year strategic national plans aligned with the SDGs. NITI Aayog produced VNR in 2018 and 2019. India's VNR and its annual reports communicate the results measured by the national indicators. The developed indicators and collected data give direction to the policymakers and the implementers of various schemes and programs (MoSPI 2016, NITI 2018, 2020).

UN developed a complex monitoring system that highlights the good practices and helps accelerate the progress on the SDGs. The monitoring is essential to assess the progress, the extent of change, and the results of the efforts taken. The 231 global indicators defined for the goals could provide a statistically measurable picture of the achievements. The collected data can help alter decisions, set new priorities, recognize synergies and conflicts, and good practices. The data gives information on the current progress and challenges and the further adaptations and resources needed to achieve the SDGs (UN 2017).

The UN monitors progress globally. The countries do additional voluntary monitoring activity, and their results are reported in the Voluntary National Reviews (VNR). Each country has the opportunity to define new indicators, and the Member States can translate the more general global targets into specific, local targets tailored to the national circumstances. To help the Member States, the concept of "progressive monitoring steps" has been introduced. Data collection starts with simpler methods, and year by year, progressively adopts more advanced and accurate monitoring methodologies. Later, data from new technologies, such as Earth Observations, geospatial data, etc., will also be available (UN-Water 2017).

Among the 17 goals, SDG6 is fundamental to all other SDGs (Figure 1). This goal addresses diverse aspects of water through 8 targets to create a life where water is equitable and sustainable for present and future generations.

Within the SDG framework, issues related to water-safety appear as an individual goal; SDG6. While the MDG focused only on drinking water and sanitation, SDG6 considers the entire water cycle. In addition to drinking water and sanitation, it addresses wastewater treatment, water stress and water use efficiency, water management, ecological aspects of water, and two horizontal targets, to

Figure 1, The water-centric 17 Sustainable Development Goals for each sector (United Nations2015c; Makarigakis and Jimenez-

promote partnership and strengthen local participatory engagement (UN-Water 2017).

UN-Water provides global monitoring of SDG 6 through custodian agencies. The JMP (Joint Monitoring Program for Water Supply, Sanitation, and Hygiene) is a monitoring program implemented in collaboration with WHO and UNICEF. JMP has been collecting data on drinking water and sanitation since 1990. It has a well-established monitoring system and adequate data to show trends. In the last three decades, JMP data collection was mainly for households. After 2015, to offer a broader picture of society, schools, and healthcare institutions included in the data collection.

The GEMI (Global Environmental Management Initiative) in collaboration with WHO, FAO, UNECE, UNSD, UN-Habitat, and UN Environment, monitors water quality, wastewater, water use, water stress, integrated water management, and protection of water-related natural habitats. GEMI was established in 2014 and currently has less global data collection and monitoring experience than JMP.

The horizontal targets on collaborations and participatory water governance are handled by the GLAAS (Global Analysis and Assessment of Sanitation and Drinking Water) agency, in collaboration with the WHO and UN-Water OECD organizations. This agency presently has very few indicators and global data (GWP 2019).

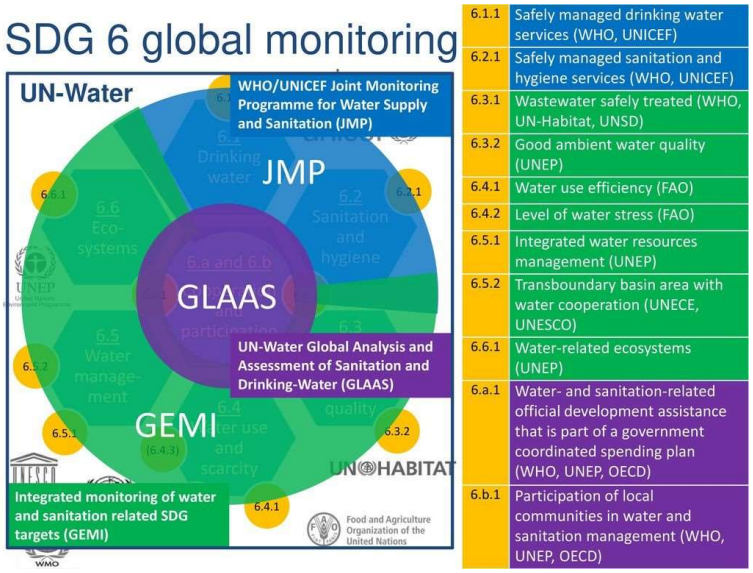


Figure 2, SDG6 Global Monitoring System

JMP, GEMI, and GLAAS are responsible for developing the SDG6 global indicators and collecting the data on a global scale. The global indicators developed so far may need to be reviewed and corrected for future monitoring processes. In a 2017 scientific article, 14 internationally acknowledged SDG6 experts have jointly published a study on SDG 6.4.2: "level of water stress" global indicator. The paper identified seven elements to analyze the water stress indicator. It acknowledged the benefits of the SDG indicator compared to the prior MDG indicator. It also highlighted shortcomings and suggested the development of the global indicator SDG6.4.2 (Vanham et al 2018). This example shows the constant progress and conversation on monitoring and indicator development. The JMP spent 30 years developing a well-functioning monitoring system for drinking water and sanitation, but the indicators and monitoring process still need improvement for the other targets. SDG6.3-SDG6.b targets lack long-term data, making it challenging to identify the related trends and required interventions.

National publications on SDG results and monitoring of Hungary and India:

Studying the global monitoring system, I noticed the countries' different attitudes towards monitoring. Hungary uses the global UN indicators primarily in its Voluntary National Review (VNR). The data on the UN-Water website is similar to the data in the VNR of Hungary.

On the other hand, India has developed its indicator system. The Ministry of Statistics & Program Implementation (MoSPI) supported Nitti Aayog's work and formulated the national indicators in 2016. In developing the National Indicator Framework, 306 statistic indicators were used, preceded by a national consultation program. India's national indicators differ from the global indicators; therefore, UN-Water presents different data on India than India's VNR.

Localizing SDGs

Global goals cannot be achieved without local efforts at national, regional, and municipal levels or even smaller territorial scales. The nrg4SD research described that the regional governments carried out activities and strived for sustainable development in their operations that fit the SDGs even before the adopted SDG agenda.

Many warned that global or national indicators are, in many cases, not suitable for measuring local progress and assisting local action. In 2016, David Satterthwaite suggested collecting some data even at the street level so that action can happen accordingly, exactly where it is most needed. According to his paper, it is essential to define local indicators and develop local data collection methods, which today lack professional direction from the UN (15). UNDP emphasizes that local initiatives are responsible for developing their local indicators and data collecting and reporting methods (GTF 2016). There are good examples of local SDG adaptation and monitoring initiatives, like the Voluntary Local Review (VLR) series (https://sdgs.un.org/topics/voluntary-local-reviews) where cities worldwide reported their SDG performances. Studying the published 37 reports, I found 12 that supported my research. These 12 reports included SDG6-specific information, targets, indicators, and monitoring methods for local objectives, problems, and opportunities, like the New York City report. (New York VLR 2018).

Relevant business sector publications:

Another form of SDG prog ress assessment is not territorial but sectoral. Business actors can support sustainable development by reducing harmful effects and increasing the positive impacts of their activities. With the adaptation of SDGs, business actors can actively participate in achieving SDGs and, through their efforts to become effective partners of governments, NGOs, and similar companies. To properly monitor and communicate their results, new indicators are needed. An inventory was compiled, with 1553 SDG indicators from widely recognized sources such as GRI, SASB, ILO, OECD, CDP, and others. However, the large quantity of indicators is not a challenge but supports companies who can use selected indicators to fit their monitoring capabilities. In addition to these indicators, companies can develop and use their indicators and data collection methods. "If the required data is not available through existing systems, other general methods of collecting and aggregating data include implementing reporting systems (for company operations and suppliers), performing field visits, questionnaires, focus groups, interviews and so on" is also recommended (WBCSD 2020). When developing my monitoring method, I studied the 133 SDG6 indicators from this inventory.

Relevant Intentional Community (IC) sector publications:

I made an additional literature review on the topic of IC's contribution to SDGs.

Monitoring SDGs is an essential but challenging task, and not all currently used global indicators are suitable for detecting changes in the SDGs on a local or territorial level.

Local indicators would be needed to promote local results. While the UN has not provided adequate assistance, some cities and companies have already developed their indicators to measure and communicate SDGs. Their work can be a good example and influence other local communities to establish their monitoring system.

Intentional Communities have been working for sustainability for decades, even before the UN SDG framework. These communities are living laboratories that use many good practices, and unintentionally contribute to achieving the SDGs locally. Scaling up these good practices to the territorial or regional level would benefit regional governments. An adequate monitoring system is needed to support such up-scaling efforts. The currently available indicators and methods are not always suitable for presenting the intentional communities' results and good practices. The development of a common SDG monitoring inventory can bring together ICs for cross-country collaborations. It can support ICs to actively engage with local and regional decision-makers and stakeholders to share the available good practices. Thus, SDG as a framework could promote the good practices of the ICs in the wider territorial region.

In 2017, GEN investigated how 30 ecovillages from 5 continents were contributing to the UN SDGs. Their findings were presented on the 2018 HLPF. Measuring the Impact of Ecovillages Figure 3 shows how the researched ecovillages` practices contribute to highlighted SDGs.

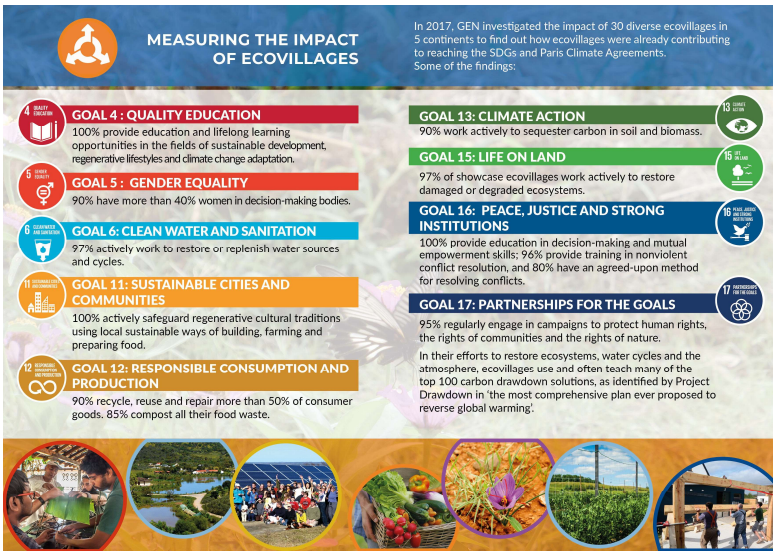


Figure 3, GEN research results, source: https://ecovillage.org/about/reports/ - 2018 Annual Report – GEN International

The GEN research questions did not use SDG-specific terminology. The report highlights the 4th, 5th, 6th, 11th, 12th, 13th, 15th, 16th, and 17th SDGs. But if we read the description more closely, we see that the Ecovillages answers were interpreted in SDGs by the GEN research team. For example, in SDG 13: Climate Action, it is written that "90% of the researched ecovillages work actively to sequester carbon in soil and biomass". While I fully agree that the mentioned activities contribute to climate action, this information does not fully capture the five targets and eight UN indicators SDG 13 has.

III. METHODS

III.1. Site visits, community engagements, participants observations

Before and during the research I had several field trips to all the researched sites. Auroville is located in India, and thanks to a Campus Mundi grant, I could spend several months in Auroville doing field research during my PhD studies.

I collected data on the eight targets of SDG6 and read the water topic-related reports. I compiled the collected data. To understand how the community relates to sustainability and SDG6 targets, I participated in several sustainability programs and activities. I have lived for several years in Auroville, and I had the opportunity to participate in water-related community activities, presentations of local and nonlocal experts, workshops, focus group discussions, and meetings.

III.2. Interviews

I collected relevant information through interviews with members. I conducted interviews with local stakeholders and experts. The research followed a "snowball" effect, only a few experts/stakeholders were interviewed at first, and then they suggested other people for interviews. As the research progressed, the number of interviewees grew by following the described thread. Fifty-six experts and stakeholders were interviewed in Auroville. I have listed them under seven topic categories, as seen in the table in the Annex.

III.3. Documents' analysis

I reviewed the datasets and reports received from the stakeholders. I collected further information from the communities' web pages and publications. A throughout literature review was made on SDG6 and its global monitoring from academia and the UN.

III.4. Laboratory analysis

I studied the literature related to the chemical analysis of water bodies, and measurement on SDG indicator 6.3.2.

I applied for grants to conduct laboratory tests on the global SDG indicator 6.3.2. Thanks to a Stichin de Zaiier grant, laboratory tests were conducted in Auroville. The water collection points were chosen based on communication with the Auroville Water Group and GIS Auroville representative. Local government-approved laboratories made the water sample collections and tests, the Environmental Monitoring Service in Auroville:

http://wiki.auroville.org.in/wiki/Environmental_Monitoring_Service.

III.5. Case studies, SDG6 monitoring Collection Site surveys

Preparations: I reviewed the literature on SDGs and particularly the relevant literature on SDG6 and the relevant government papers were studied from both countries. I reviewed the literature on

targets and indicators of SDG6 and collected these in an indicator compilation to which I later added

suggestions (Available in Annex)

While conducting stakeholder/expert interviews and participating in activities, I realized that Auroville is complex and lacks centralized administration. To overcome this obstacle, I decided to do site visit surveys. I developed the SDG6 Local Monitoring Survey and used it on each site survey.

I visited each site and did surveys with interviews and field trips. The surveyed sites were chosen to represent the variety and functional aspects of Auroville. It includes seven types of sites. Conducting these surveys, I followed the snowball effect. Initially, only 2-3 sites were chosen from each type, and then those sites were contacted and visited, which were suggested to me. As the research progressed, the number of visited sites grew by following the thread. Eventually, the size of the visited sites grew to 65. While visiting the first 11 sites I reshaped the data collection sheets. I mention them here (Akashwa, Auroorcahard, Auroville Papers, Budha Garden, Coin de Terre, Gaias Garden, Village Action Group, Fertile Forest, Auroville Future, Palmyra, Solitude Farm), as their data is not included in the diagrams and excel sheets, but has impacted my overall view on Auroville at its large. The interim conclusions are based on the data from 54 sites. The time frame restricted the option of further expansion of the research sites.

III.6. Plenary discussions on the results

I processed and evaluated the obtained results, and presented them to the community members on organized and announced plenary sessions.

In Auroville I presented my research results in a local plenary session, responding to the questions raised.

The discussion was recorded, and I later included the reflections in my conclusions.

I complemented my research findings with the received feed/backs.

IV. RESULTS AND DISCUSSIONS

IV.1. Introduction to the researched community sites

Auroville is situated on a 20 km^2 area of the Coromandel Coast on Bengal Bay in South India. It was founded in 1968, in the presence of more than 5000 people, representatives from UNESCO and 149 countries. Auroville aspires to become "the city the Earth needs", with a maximum number of 50.000 inhabitants. Today 2907 people from 59 countries live and work there. The area is characterized by a tropical monsoon climate, where sudden heavy rainfalls follow long dry periods. Archaeological research has shown that the Auroville area has been densely populated since ancient times but wildlife and forests were relatively undisturbed. During colonial times, forests were seen merely as opportunities for harvesting, and only the Sacred Groves were spared, where people for generations protected the trees through religious restrictions. Over the last 200 years, the native vegetation of the area, Tropical Dry Evergreen Forest (TDEF), has been largely eradicated. The rain has quickly removed the soil in the absence of groundcover, leaving behind a heavily eroded landscape. From the slightly sloping area, the rainwater ran towards the sea, shaping canyons on its way. The land of rich forests had become a large barren plateau that turned into a swamp when it rained and into a reddish desert during the dry seasons. A 1960 research by UNESCO declared the land unfit for human habitation.

The pioneering years of Auroville mostly focused on landscape rehabilitation through reforestation and water management. As the number of inhabitants increased, a sustainable city evolved with integrated urban development, organic agriculture, and alternative energy plants. The aim was to create an area suitable for human life. Today, Auroville is considered an ecological wonder with its luscious, green environment (Nagy 2018).

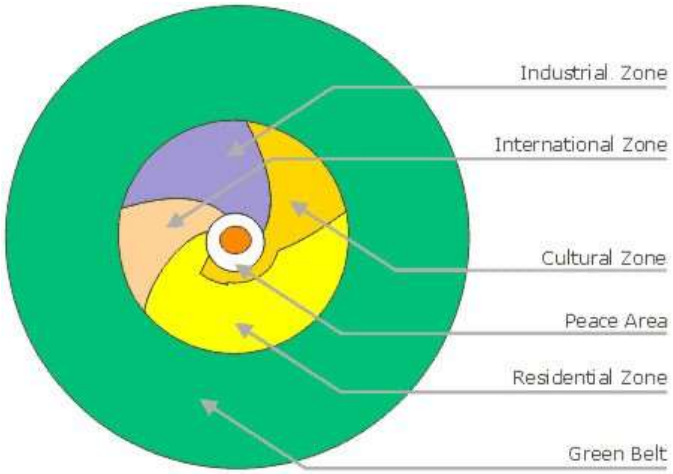


Figure 4: Auroville Master Plan

The Auroville Master Plan consists of five zones the: Industrial Zone, International Zone, Cultural Zone, Residential Zone, and the Green Belt.

I divided the researched sites into seven categories as listed and described below. Please look at the Annex for more information.

Habitats: These are residential communities of various setups. A few storeys building or a site with separate houses or a combination of the two.

Forests: These sites focus on forest and landscape restorations. A few individuals and families live on these sites, who are all involved in forest management. Forests host educational activities and volunteers who want to participate in the reforestation work.

Farms: These sites focus on organic agriculture. A few individuals and families live on these sites, who are all involved in farm management. Farms host educational activities and volunteers who want to participate in the farming work.

Industrial complexes: These sites host one or more small-scale industrial units. Most of these sites don't have residents, but some may have a caretaker or a caretaker family as a resident.

Institutes/ Cultural Centres: These sites host community programs and cultural activities. Schools are also included in this category. Most of these sites don't have residents, but some may have a caretaker or a caretaker family as a resident.

Service Complexes: These sites are visited continuously by a flowing number of aurovilians, usually hosting several services on their site. Shopping, health, financial tasks, and administrative offices are located on these sites. Most of these sites don't have residents, but some may have a caretaker or a caretaker family as a resident.

Guest facilities: Auroville is visited by an estimated 1 million people per year (not during the COVID-19 pandemic). Most visitors spend only a few hours in Auroville, while others stay for a few days or more. Many come from universities to learn about sustainable practices. The sites of this category specifically focus on hosting guests.

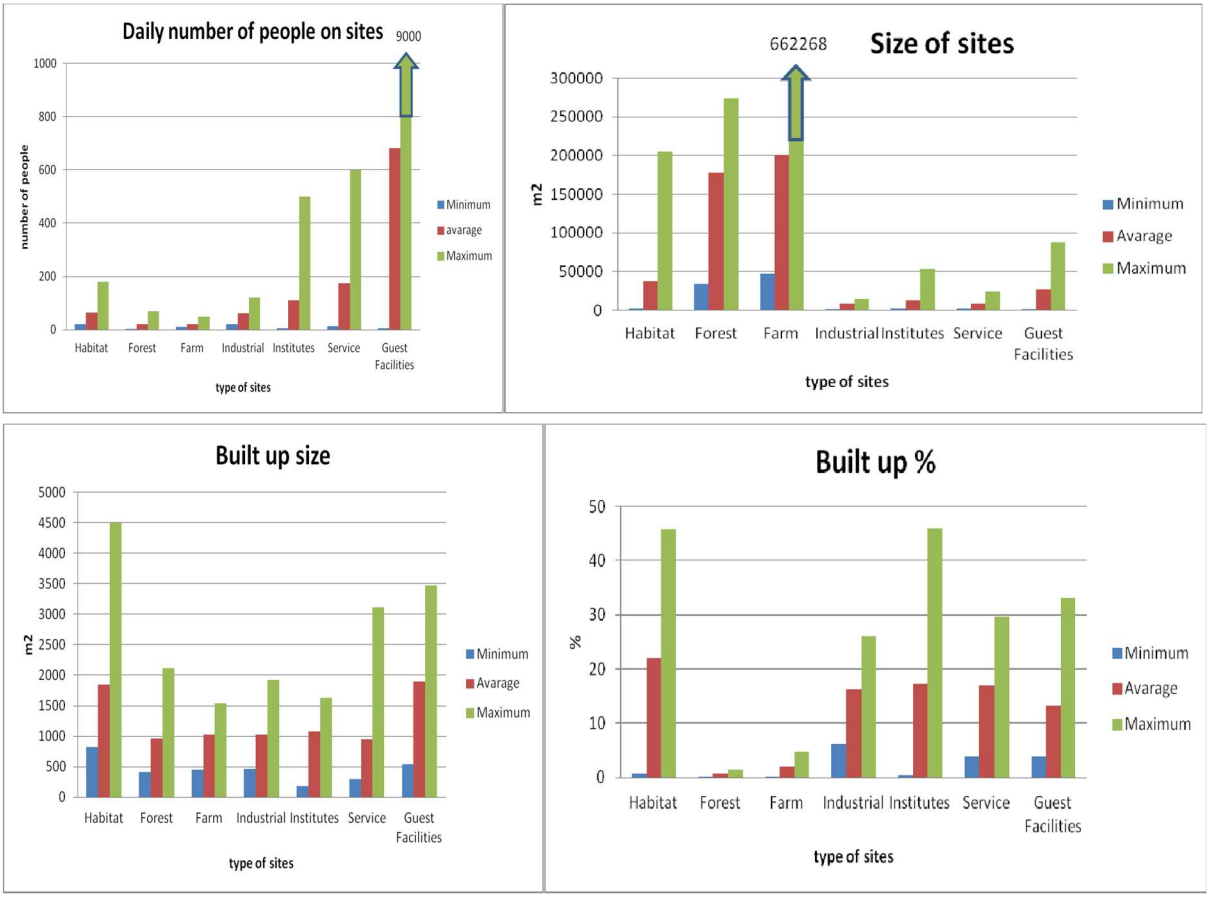


Figure 5, Researched sites' parameters

As shown in the above diagrams Institutes, services, and guest facilities are visited by most people, while forests and farms are the least visited with the largest unbuilt land. This leaves a relatively large space undisturbed by humans for flora and fauna. More info in the Annex.

IV.2. SDG6.1

The SDG6.1 target is: "***By 2030, achieve universal and equitable access to safe and affordable drinking water for all".***

This above sentence is the result of a long planning and negotiating process. Each word has a special meaning. Next, I will use each word with its normative interpretations to frame the collected data. UN identifies "drinking water" as water used for drinking, cooking, and personal hygiene. In the researched communities the water used for cooking, and personal hygiene goes through different treatment processes and storage as the water is directly consumed.

Universal: ***"****Implies all exposures and settings including households, schools, health facilities, workplaces, and public spaces" (Normative Interpretation, UN, 2016).*

As per Town Development Council information, all households, schools, healthcare facilities, and workplaces in the City area are supplied with piped water. The piped water is pumped from covered, protected borewells with solar, wind, or electric pumps. In most sites, the water is stored in highly-placed tanks from where it flows in the pipelines by gravity. Among the latest buildings, there are sites where water is stored in underground tanks, from where it further flows by the power of electric booster pumps. In the early days, water was provided from various sources, including open borewells and handpumps. Nowadays, these are rarely used, but there are still a few sites in the Green Belt, with open borewells or handpumps as supplementing alternatives to the piped water of covered protected borewells.

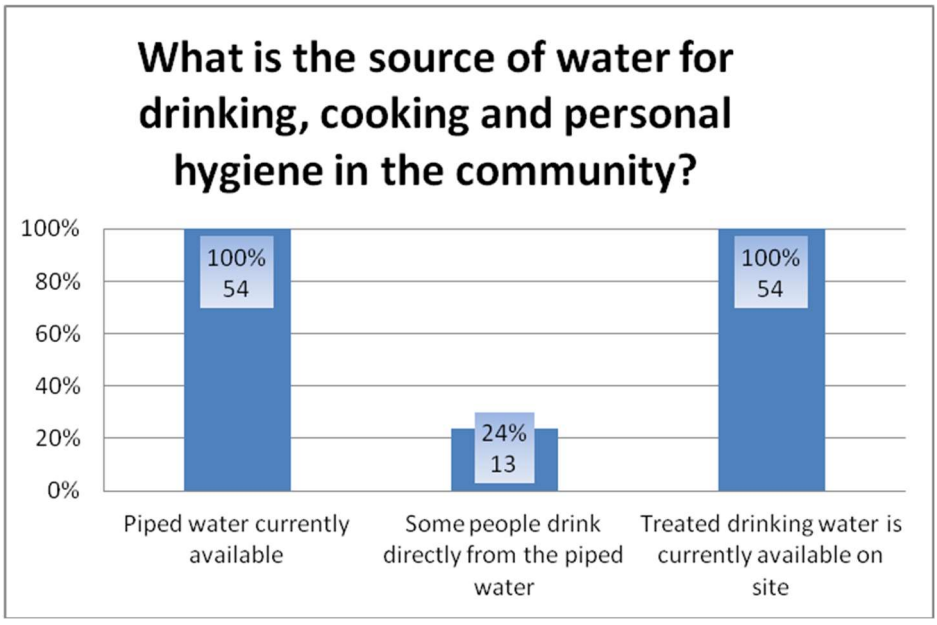


Figure 6, Source of drinking water

All researched sites are supplied with piped water, but this water is untreated. In all researched sites, treated water for direct drinking was available in small refillable containers, as it is suggested to use only treated water for direct drinking. Nevertheless, it was reported that in 13 sites, some people regularly drink untreated piped water without any experience of water-borne diseases.

Equitable: *Implies progressive reduction and elimination of inequalities between population subgroups (Normative Interpretation UN, 2016).*

Auroville has developed gradually for the past 50 years parallel to the population growth as in Figure 7.

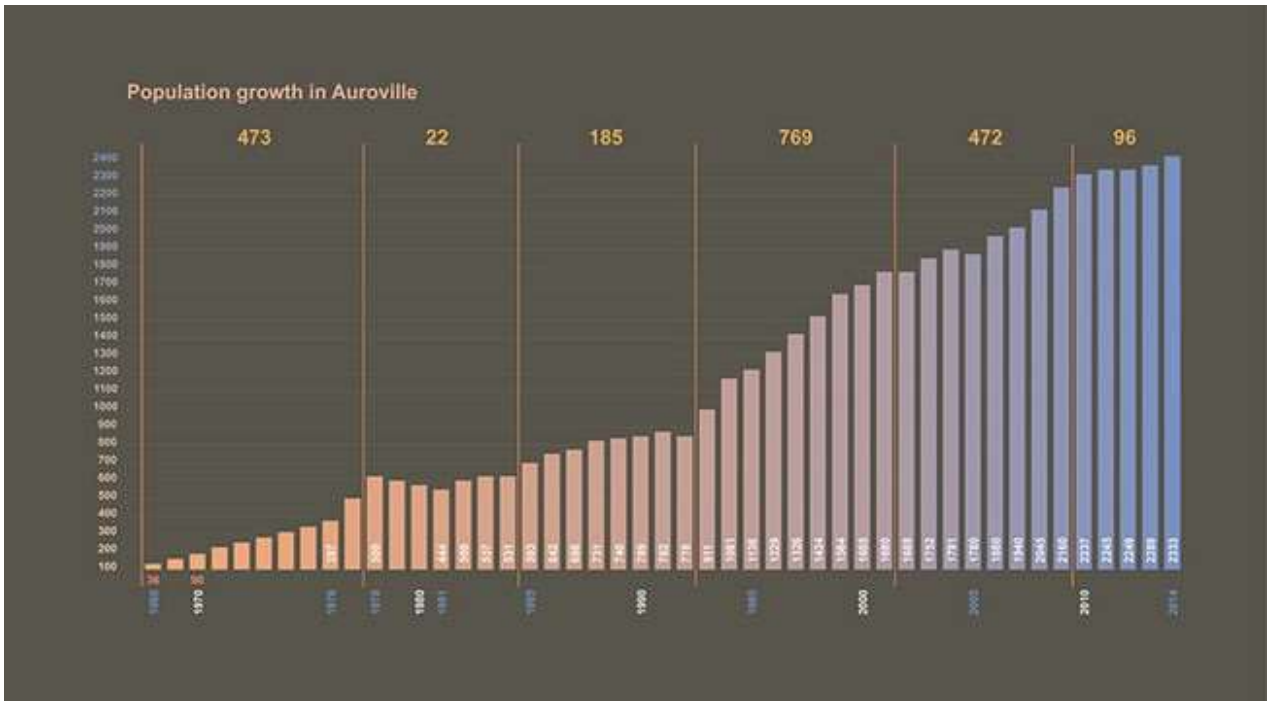


Figure 7, Population growth in Auroville

As the population grew, new needs arose, and technologies were explored to cover those needs. Some communities in the Green Belt still use technologies that were modern solutions 30 years ago. In the City area, some of the newly developed buildings are equipped with recent technologies. This difference creates a slight difference in the level of comfort and simplicity, but it also gives freedom of choice to the residents of Auroville. Fertile Forest, situated in the Green Belt advocates for a simple lifestyle. The seven houses of Fertile Forest co-manage the community's piped water system. Each home is equipped with water tanks at different heights, and residents have to adjust their water uses to others' needs during the year's dry periods. It creates interdependency and a strong community bonding experience. People living in the City area apartments have a centrally managed inflow water system, thus experiencing independence in their private water uses. Nevertheless, these differences are not to be labeled as inequity. This level of independence or interdependence is not measurable by the UN drinking water accessibility and affordability indicators.

By today, three types of piped water supply systems have evolved, which are co-creating equitable water security in Auroville.

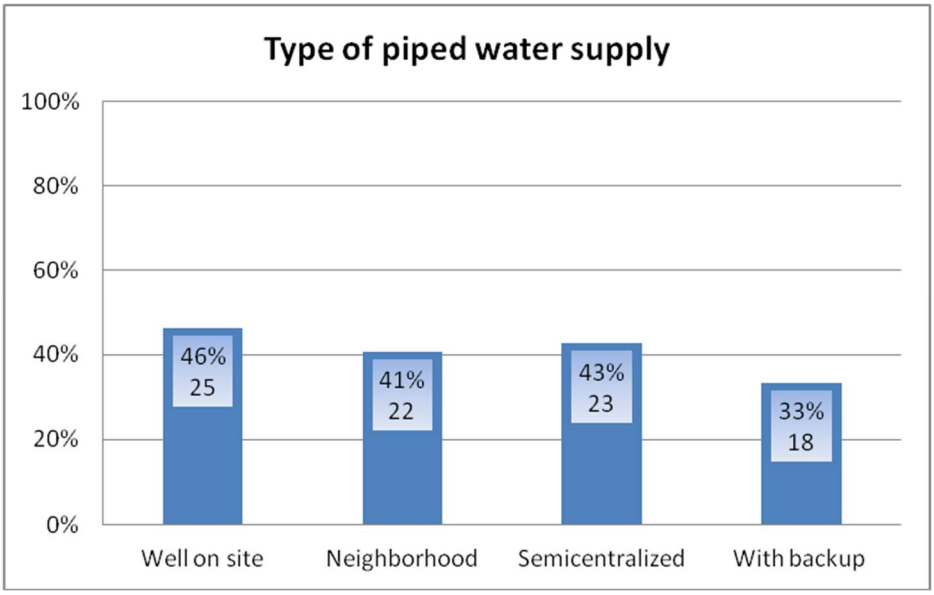


Figure 8, Piped water supply

Site-level systems: In pioneering years, when the sites were distant from each other, divided by large empty fields, the water needs were fulfilled from closed and separate systems that included borewells located within sites. Today these systems are still broadly used, like in Fertile Forest. In these sites, attached water tanks are first filled up by running the pump for some time of the day. The water tank then stores and provides the water during the day. Some community tanks only need to be refilled every 2-3 days, while others are refilled every day. Among the visited sites, 25 sites had their private well located within their sites and ran an on-site managed system.

Neighborhood systems: As the empty fields became new sites and the number of sites gradually grew, some new sites connected to the neighbor community's already existing water system. Then the neighborhood system has evolved, where several sites share one common borewell. In these systems, the borewells are managed by their location while pipes, running to the neighborhood sites, provide water. Each site is equipped with private water tanks and receives water through the pipelines daily, at a specific hour. Like every morning, 8-9 am, the water flows to one site and from 9-10 to another. Each site fills up its tanks, and during the day the water is used from the water tanks.

Semi-Centralized Systems: A few semi-centralized water suppliers offer daily water for numerous sites through the pipes. These systems have evolved from the neighborhood system experience and have one or more big tanks to provide water throughout the day to their users. (Figure, 8) There has been a growing opportunity for access to the semi-centralized water system in recent years. Currently, there are four such systems located in different parts of Auroville. The biggest is the Auroville Water Service (AWS), which offers inflow water

Figure 9 Elephant Tower

24 hours/day, seven days/week to its 1200 users.

Access: *Implies sufficient water to meet domestic needs is reliably available close to home (Normative Interpretation, UN, 2016).*

We can state that water is generally provided seven days a week, 24 hours per day. Of course, there are occasional limitations due to maintenance or repair works.

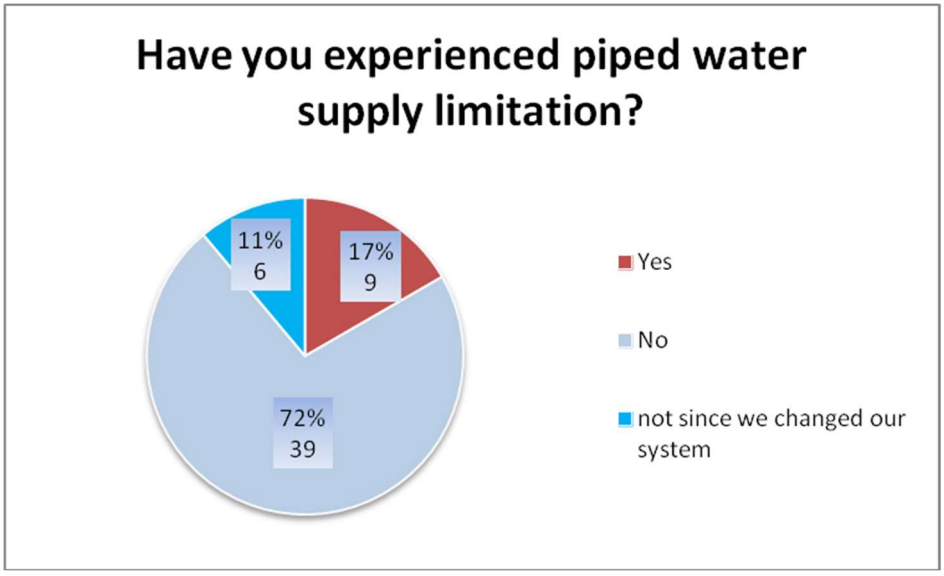


Figure 10, Limitation in water supply

Out of the 54 sites, nine have experienced occasional or reoccurring limitations in their water supply. Six of the visited sites have reported that no water shortage reoccurred since they have changed their water supply system by drilling a new well, changing the water tank's size, or changing the water supplier. Other sites have reoccurring water limitations due to electricity problems or the breakdown of pumps or water purifier machines. Many sites have experimented with alternative water security solutions throughout the years. Coming from decades of town evolution and learning from past experiences, most services and sites have some "backup system" to provide water all the time. AWS maintains several borewells that are alternately used. Some sites also have two or more borewells for alternate usage. Fertile Forest has two borewells, one is equipped with a windmill pump, and one is with a solar pump that does not function well during heavy monsoon. On those days, the community has less water need (as no irrigation is needed) and is sustained by the lower yield windmill well.

Another system for water security is a backup pipe system to a neighborhood well. Fraternity and Aurolec are connected by an underground water pipe system. While both sites have their separate site-level systems, the sites provide water to each other through pipes when needed, e.g. during pump or well maintenance. Other communities chose to connect to more than one water supplier system. Verite borewell and underground roof-rainwater catchment tank generally provide enough water; still, the site is connected to a semi-centralized supplier as a backup for water shortage situations.

In addition to these solutions, two Auroville services offer 6.000-liter capacity mobile water tanks on constant standby, and one contains laboratory-checked safe drinking water. These can be pulled to the site of a water shortage emergency.

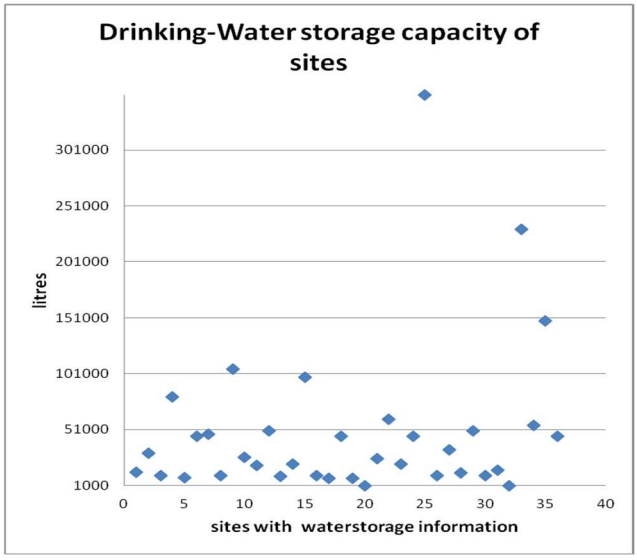


Figure 11 Water storage capacity of sites

Out of the 54 sites, 48 were equipped with site- located underground or overhead water tanks. The remaining six sites were connected directly to the AWS overhead tank, with an inflow water system. As the construction, purchase, and maintenance of the water tanks are costly, a recent tendency shows that the newly developed sites prefer to receive direct flow water without site-managed water storage.

As shown in Figure 10, most sites are equipped with less than 50,000 liters of water storage capacity, and the average water storage capacity of the researched sites is 48604 liters.

While six sites did not have any storage capacity, 12 sites could not provide the data on their storage capacity.

Figure 12 Sacred Groves central building with its underwater roof-rain water tank

In recent times, more experiments happened on roof-rainwater capture and storage in underground tanks, like in Sacred Grooves, which has a capacity of 350000 liters of water storage, which was the largest among the researched sites, (as in Figure 11).

It is suggested to treat the water before direct drinking, and most Auroville sites are equipped with a water filter or purifier. During the research period, four sites were collecting drinking water from high-capacity public drinking water fountains. Two of these sites had a temporary water purifier breakdown, and they were relying on the public filtered water source for the time of repair. Two sites transported drinking water in refillable containers from the public fountain as a permanent solution due to their experienced difficulties with water filter maintenance. As per the JMP questionnaire, I asked about their time spent on drinking water collection. The longest time was 20 minutes, while the shortest time was 5 minutes.

Safe: *Safe drinking water is free from pathogens and elevated levels of toxic chemicals at all times (Normative Interpretation, UN, 2016).*

As per the UN definition, drinking water is used for drinking, cooking, and personal hygiene purposes. In many parts of the world, water for direct drinking purposes differs from the water used for cooking and personal hygiene. Treatment methods are often too costly to include all water used for cooking and hygiene purposes. Water drank directly presents a higher health risk; that is why different water is used for drinking directly, one that is treated.

Auroville: Treated, safe drinking water is available on all sites. While most sites are equipped with their treatment systems, four sites transported the drinking water from a nearby public AquaDyn fountain during the data collection period. Among the various water treatment methods, several are used in Auroville. The microbial removal processes include microfiltration, UV radiation, chlorination, and reverse osmosis. As seen in Figure 12, most sites are equipped with an electric water purifier, and in many sites, the ceramic filters are still in use as an additional tool. Chlorination is only used in one of the visited sites, Solar Kitchen, the main restaurant that provides food to all schools and most citizens. They follow a thorough combination of various filtering methodology series with chlorine injection that offers maximum security for all food items.

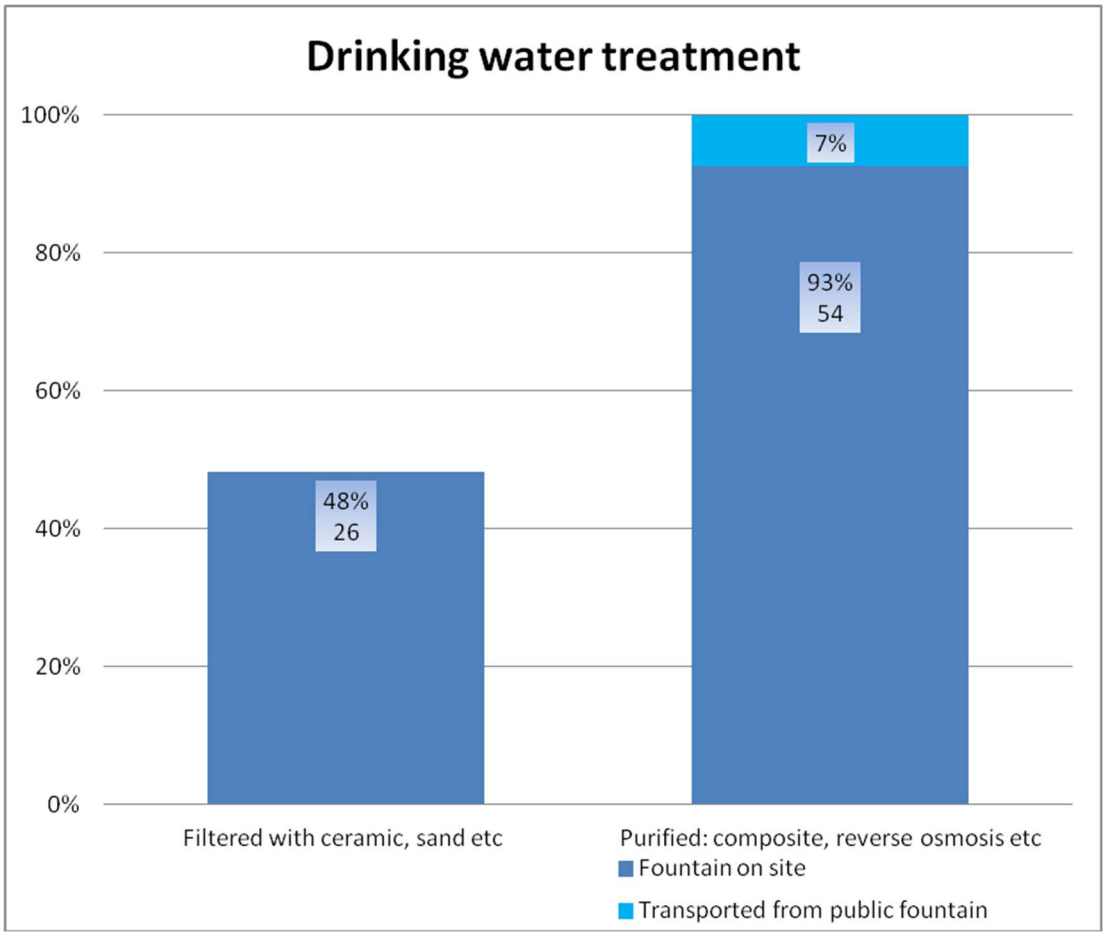


Figure 13, Percentage of the used drinking water treatment methods on the sites

Various purifiers are used within Av, and the most popular are manufactured by the AquaDyn Company and industrial unit of Auroville.

AquaDyn Auroville was established in 1994 as a Research and Development Centre on pure and living water benefits. AquaDyn Auroville has collaborated over time with many worldwide physicists and scientists to develop its water purifiers. Today, the AquaDyn team comprises over 20 engineers, designers, and technicians from India and abroad and encourages continual technological innovation. AquaDyn Auroville's technology provides high-quality water

purification with added bio-dynamization, Light & Sound® information, and trace elements saturation system.

AquaDyn manufactures various capacity water purifiers and offers regular maintenance services. Capacities vary from 10 to 10.000 liters/hour. Sold water filter data has only been available since 2011. This data shows more than 300 machines sold in Auroville, 230 elsewhere in India, and 2000 machines purchased for international sales. The company estimates that around 500 devices are used and maintained in Auroville. Several high- capacity public water-purifier fountains are located in Auroville, from where water is collected and transported continuously.

Only one habitat site has reported mild symptoms of water-borne disease in the past five years. The residents consumed water from the site's public water purifier fountain. When suspicion arose that the drinking water might contain pathogens, water samples were tested in the local EMS laboratory, and immediate steps were made to provide safe drinking water from an Auroville source. Several maintenance works were done on the site, like cleaning and sealing the water tank and water purifier, followed by a laboratory examination. This procedure was repeated until the problem was solved, and the laboratory tests showed no more pathogens in the drinking water.

This example highlights another vital element to drinking water safety: the available and accessible laboratory service.

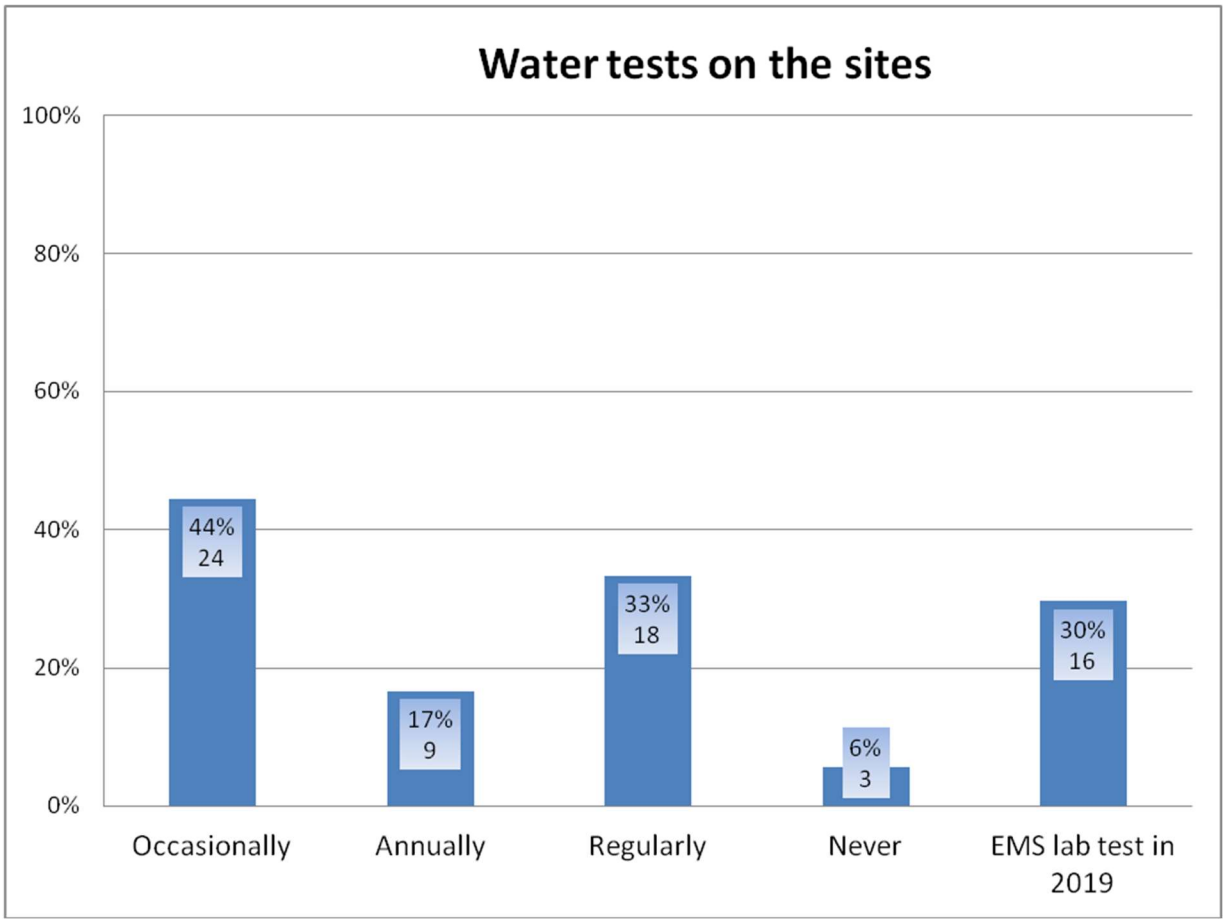


Figure 14, Occurance of the laboratory water tests of the sites.

There are various water purifying systems used in Auroville, each has advantages and disadvantages, but none of them is absolutely reliable. The laboratory tests remain important to control drinking water's purity. Out of the visited sites, 24 reported ordering lab tests occasionally, when water quality change is noticed, or if contamination is suspected. The remaining nine sites claimed to order at least yearly laboratory checks, and 18 out of them reported ordering tests every 1-3 months. Generally, food providers or food servers like schools, community kitchens, restaurants, and guest facilities order regular laboratory water quality tests.

In the early days, laboratories were located distant from Auroville, and to address the need, a laboratory was formed in Auroville. The Environmental Monitoring Service Laboratory (EMS) is an Auroville service located in Aurobrindavan community. It was started in 1993 as a municipal laboratory for water, soil, and food analysis.

Presently six people, including two M.Sc. microbiologists, one M.Sc. chemist, field workers, and a lab assistant work at EMS. It provides various microbiological and chemical analyses not only for Auroville but also for the surrounding region.

I had the opportunity to access the 2019 test reports of EMS. The last column in Figure 9 shows that only 30% of the researched sites ordered a microbiological laboratory test from EMS in 2019. The reason for the difference between the number of sites claimed to have at least yearly lab tests and the number of sites that EMS tested in 2019 can be various. One explanation can be that not all sites use EMS for their regular drinking water lab check-ups. Sites with special permission to produce and sell organic food products are obliged to do lab check-ups by the official Tamil Nadu government laboratory.

For the 16 sites, 257 samples were tested on Total Coliform and E. coli. Several water sources were examined, including tap water, well water, tank water, water from the filters, and purifiers. Data showed no contamination in the samples from wells, purifiers, and filtered water containers. However, tap water and tank water data indicated high contamination in some but not all the sites. The data showed no contamination of E. colli in 250 samples, and 200 samples were free of Total Coliform contamination.

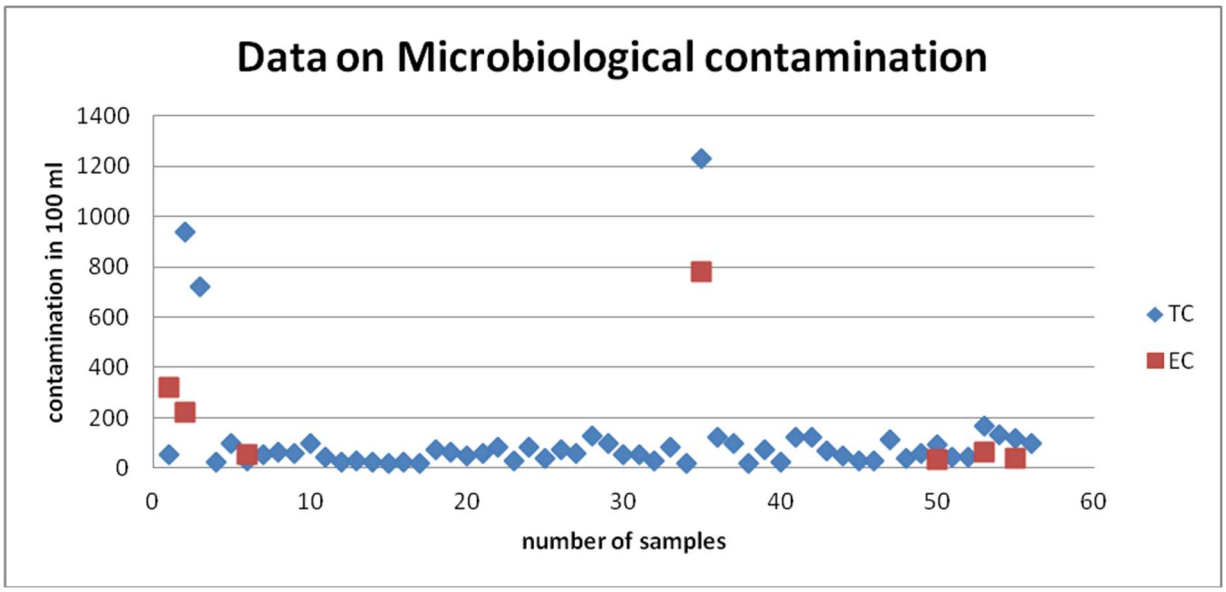


Figure 15, 2019 contamination data of samples from tap water and water tanks

In 2002 a throughout water test series was made by EMS financed by a grant. This research included microbiological and chemical analysis of 3522 water samples collected from Auroville and its bioregion. I compared the 2002 and 2019 data from six sites.

Table 1, Microbiological contamination

	2002		2019	
	nr of samples	nr of contamination	nr of samples	nr of contamination
Solar Kitchen	41	10	13	1
Pour Tous	12	1	11	1
Aurolec	9	3	8	0
Aquadyn	1	0	3	0
Quiet	2	0	34	0
Visitors Center	3	0	9	0
All Data	76	14	78	2

The table shows that the same number of tests were made in the sites, and there was a significant drop in contamination occurrence since 2002.

Chemical analysis of water quality:

Today EMS rarely requested to do chemical analysis; none of the researched sites requested a chemical analysis from EMS in 2019. Agriculture uses only organic methods, and there are no polluting industries in Auroville. That is why water is assumed to be chemical contamination-free, and no one requests regular chemical analysis of water quality. The 2002 chemical analysis report reinforces this assumption. *"Conclusion in Auroville: 62 sources of water have all analyzed parameters within desirable limits, and water can be used for drinking. 23 sources of water have some parameters more than the desirable limit, but still within the permissible limit, water from these sources can be used for drinking purposes in the absence of alternate sources. There are no sources of water with parameters beyond the permissible level. All pesticides in water detected in the Auroville area from 6 bore wells have a less than permissible concentration, and water can be suitable for drinking purposes. Conclusion in Auroville Bioregion: 41 sources of water have all analyzed parameters within desirable limit and water can be used for drinking purpose 55 sources of water have some parameters more than desirable limit but still within the permissible limit, water from these sources can be used for drinking purpose in absent of alternate source. 43 water sources have some parameters more than permissible level, and water from these sources can not be used for drinking purposes without special pretreatment."*

The report showed a significant difference in the chemical and pesticide contamination of the waters of Auroville versus its bioregion. Alok, a scientist of the Auroville Future, is deeply concerned about the groundwater's chemical parameters. While no chemical threats from Auroville enter the aquifers, the neighboring farmers use pesticides, and the industrial sites near Auroville, are rumored to dump chemical waste directly in old bore wells, endangering the commonly shared groundwater. Alok decided to regularly check the groundwaters' chemical qualities to know of any pollution before it would cause health risks. He recently started a new throughout chemical analysis on the water samples collected from Auroville wells.

EMS did thorough water analysis research in 2002 for ACUR. Since then, it has not received further grants for continuing such research, and data was only collected and analyzed for individual requests, site by site.

In any case, we can underline the fact that regular laboratory check-ups and awareness are present in Auroville. EMS offers a well-known and commonly used and appreciated community service. Water is tested for microbiological pathogens within one day. The laboratory provides water quality check-ups for all the schools free of charge.

Many Auroville sites reported having regular lab-check-ups in the past to provide safe water for drinking. Based on these tests, they created safety protocols to maintain their water quality and avoid contamination. The sites follow strict maintenance and cleaning procedures to maintain safe drinking water quality.

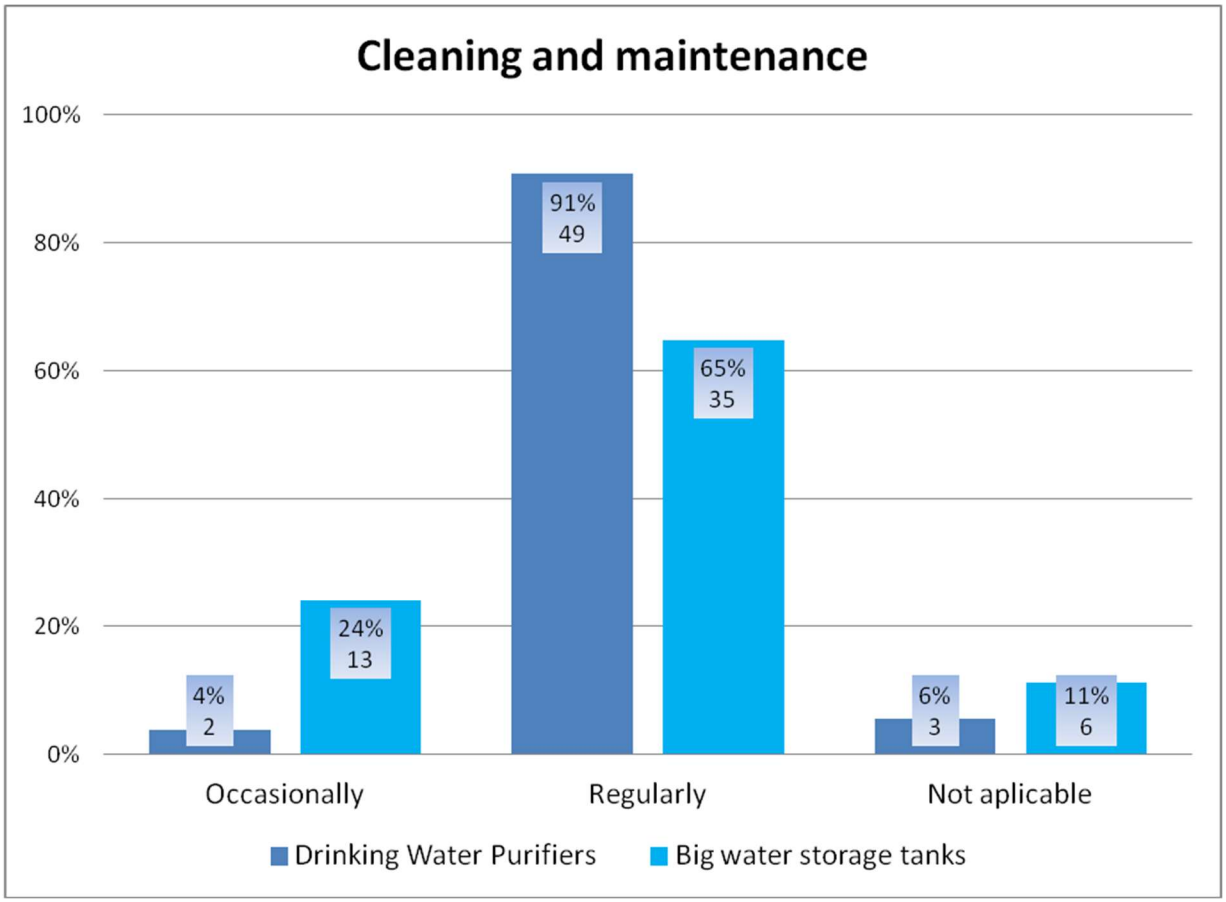


Figure 16, Cleaning and maintenance of water purifiers and big storage tanks.

Figure 15 shows that most sites do regular cleaning and maintenance work on the water purifying machines and water storage tanks. Water tanks' cleanliness is maintained in all sites to protect the water from pathogens. This work is done by the site management or by professional water services of Auroville. Water purifiers are more regularly maintained than water tanks and usually by a professional service provider. Filter maintenance takes less time, and it is required to be done every three months. The portable and refillable drinking water containers and filters are easier to clean, and it is done regularly by the site management alone.

If the above-listed safety procedures are done, the risk of waterborne disease is relatively low.

Some sites did not have any water tanks or purifiers, and they were labeled as not applicable because this maintenance work was not needed. These sites receive drinking water from public water-purifier fountains or inflow water from the Elephant Tank. These are regularly maintained and cleaned by service providers like AquaDyn or Auroville Water Service (AWS).

While most sites' drinking water has excellent and favorable taste, in eight sites the residents noticed a change in the water quality, as it became harder in recent years. This change is probably connected to the drop in water level. In Quiet Healing Center, located on the coastline, groundwater became salinated and unsuitable for drinking and irrigation purposes. A mini desalination plant was implemented to provide water for drinking and irrigation.

Old pipes of Auroville are claimed to leak and have a health risk by polluting the drinking water with microplastics. That is why AWS, in recent years, has changed most pipelines to a renewed pipeline within the City area. The newly used HDPE pipes are claimed to be safer for humans than the previously used PVC pipes. In addition, AWS had 30% water loss in 2000, but it has reduced to almost 0% water loss with the change of the pipes.

Figure 17, HDPE pipes

And affordable: *Payment for services does not present a barrier to access or prevent people meeting other basic human needs (Normative Interpretation, UN, 2016).*

There is an ongoing debate in Auroville on whether water should be charged or not. Some people say that monthly payments based on water meters' data create awareness and limit water use. Others mistrust the water meters' accuracy and argue that water should be freely provided as a basic human needs.

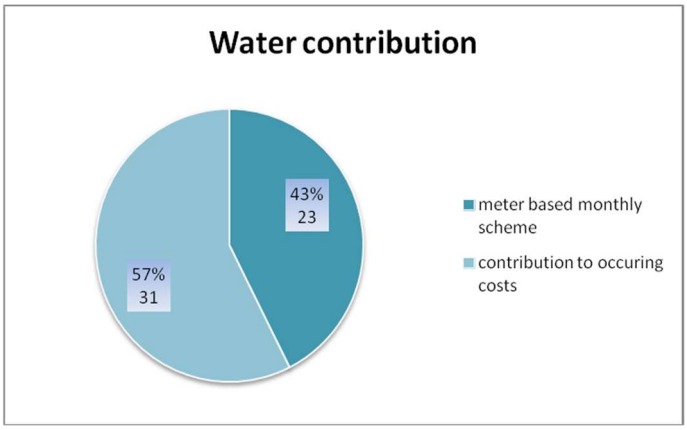


Figure 18, Contribuition to water

Auroville water provision and distribution have evolved step by step throughout the past decades, parallel to the slowly increasing number of habitats. As the water supply systems changed from site-managed to neighborhood and semi-centralized systems, the contribution type to their maintenance also changed. In general, today, there are two types of contribution type to the water. In the maintenance scheme, the users don't pay for the water, and water is not metered, but repair or maintenance costs may occasionally occur. All users contribute to the occurring costs based on their budget and estimated consumption.

The service scheme users receive the water from a supplier, who meters the site's consumption. This metering can happen by a water meter or by timing how many minutes per day the water is provided for each site for water storage tank refill. Based on this data, a monthly bill is provided. The payment

covers the service's running costs and keeps a surplus aside for recurring repair and maintenance costs. In most cases, the water is metered on a site level, not on the household level, and the bill is shared among the site users and residents.

On 36 sites, water costs are exclusively covered by an institution or an income generator, like forest management or a workshop located on the site. On nine sites, the users share the water costs equally or based on their consumption. In mixed participation, institutions/income generators and users cover the water costs together. It means that the main income generator of the site covers most costs, but us the household level to provide drinking water for a relatively low cost.

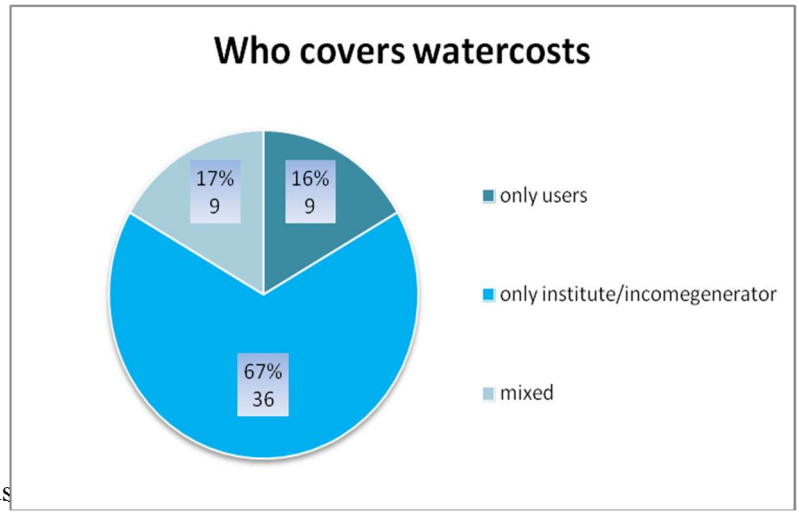


Figure 19, Water cost is cover by

The Varuna Scheme, which is presently providing free electricity to Aurovillians, plans to use the desalinated water to provide piped drinking water free of charge to all Aurovilians in the future.

Drinking water: *Water used for drinking, cooking, food preparation and personal hygiene (Normative Interpretation, UN, 2016).*

Available on all sites for all purposes both in AV.

For all: *Suitable for use by men, women, girls, and boys of all ages, including people living with disabilities (Normative Interpretation, UN, 2016).*

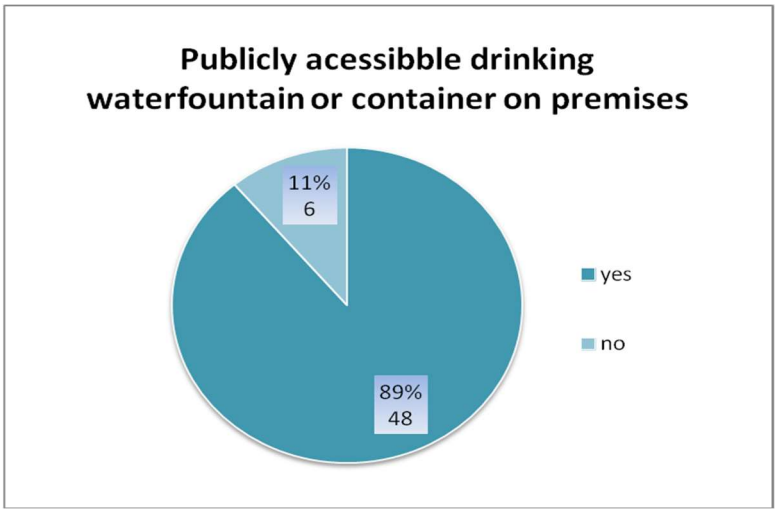


Figure 20, Drinking water resource on site

On 48 sites, an open-access drinking water container with glass is placed, offering drinking options for anyone passing by. The remaining six sites have no such open-access hydration center, but drinking water is available upon request from the private households.

The drinking water sources were accessible on all sites for men, women, girls, and boys of all ages. Some places have additional access for people in wheelchairs. While people with disabilities rarely visit most sites, one of the researched sites, a school, educates special needs children. This site is equipped with specific tools that assist with their water access.

Four high-capacity public water purifier fountains (HCPWP) are placed in Auroville. These fountains are well-maintained and regularly checked for water quality. The four fountains are located in different corners of the Auroville area, offering easy access to filtered water.

There are two well-established ways to supply drinking water for temporary break-downs or on special occasions like outdoor programs, gatherings, or sports events such as the Auroville Marathon that happens once a year with more than 7000 participants. One such solution is a portable HCPWP provided by AquaDyn, which can be used locally by connecting to an on-site water tank. The other is a 6000-liter mobile stainless steel drinking water container stored in the AV Future site and pulled to where needed. The container is well maintained, and the water quality in this container is regularly tested, so it stores safe drinking water.

DISCUSSION

Target and its achievement.

The normative interpretation divides the target into eight parts, each of which is well-suited to the functioning and goals of Auroville.

The researched community has a piped water supply that is reliable and accessible.

Each community primarily relies on groundwater as a source of drinking water, and efforts are made to preserve its **quality**.

Hazardous contaminants are prevented from entering the soil or water. The practice of organic agriculture reduces the threat of **chemical contamination**. Special attention is paid to the quality of the pipes. AV has replaced waterlines.

Strictly followed hygienic practices reduce the risk of **microbiological contamination**. Besides, the ecovillages rely on modern science, with regular and occasional water analysis. If a suspicion arises of microbiologic contamination, laboratory tests are requested to identify the source of contamination. The tests are repeated and followed by cleaning and maintenance work until there is no contamination in the water. Based on these tests, the hygiene and maintenance procedure is continuously re-shaped. In these resilient communities, laboratory tests lead the adaptation and development of hygienic protocols.

Diversification of piped water supply systems and various backup systems ensures the **quantity** of water supply. In AV, at first, single-standing wells were drilled, which later formed into smaller and larger collaborations of semi-centralized water supply services. KRV, on the other hand, went in the opposite direction. At first, there was a major water network, and later independent wells were dug. Today characterized by a diversity that includes both central and individual solutions, which work together to create and maintain the water safety of these resilient communities.

Directly consumed drinking water undergoes different treatment and storage than piped “drinking water”. The treatments are sophisticated, purifiers with reversed osmosis are the most popular.

Centrally located drinking fountains provide free access to purified drinking water. Local and neighboring residents can collect drinking water for free in their portable containers, while plastic bottled water is restricted. Drinking water is transported, where the purification is not solved due to technical difficulties.

Water meter and water price data is not collectable. The technical reason is the lack of water meters, but there is also a question of principle. Some residents don't feel right about the pricing of water, to which metering is seen as a first step.

Additional targets: While it is not explicitly mentioned or addressed in the UN target normative interpretation, there is an effort to reduce the use of bottled drinking water in Auroville. Two measures are practiced: setting up hydration centers or public drinking fountains in publicly accessible locations and prohibiting the selling of bottled water. Several drinking water fountains are placed in the Visitors' center, which hosts 1000-8000 visitors daily. A vendor sells long-lasting refillable water bottles next to the fountains.

Indicators and monitoring:

With the literature analysis, I found 28 indicators, many of which can be used for IC monitoring. However, JMP monitoring questions collect additional data that is not presented by the available indicators. I added 40 questions to the monitoring list.

The UN definition of drinking water, including water for cooking and personal hygiene, is disadvantageous to ICs. In the studied ecovillages, water for direct drinking, cooking and personal hygiene are treated and stored separately. The JMP monitoring emphasizes piped water supply but does not adequately address the piped water quality. In India, piped water microbiological contamination is a problem, while Pittsburgh VLR mentioned lead contamination from old pipes. Unfortunately, the target and monitoring do not address the issue of plastic bottled drinking water. Efforts to reduce plastic bottled drinking water are mentioned in Los Angeles' and Sydney's VLRs, and practised in the ecovillages. They tackle the problem by locating central drinking fountains and restricting the distribution of plastic bottled water.

Conclusion: The SDG 6.1 target and most of its indicators are suitable to refer to and monitor Auroville's aims and activities. Additional targets and indicators are needed to monitor the quality and quantity of directly consumed drinking water and address plastic bottled water consumption.

IV.3. SDG6.2

By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.

Achieve access: *Implies facilities close to home that can be easily reached and used when needed (Normative Interpretation, UN, 2016)*

As per the Town Development Council of Auroville, all homes, schools, healthcare facilities, and workplaces are equipped with sanitation and hygiene facilities, and these facilities are accessible when needed.

In the early days of Auroville, toilet facilities were located outside of the households and were shared among several homes. Nowadays, the tendency is to build private toilet facilities for the families located within the dwelling, but shared and outside toilet facilities still occur in the Green Belt area.

Among the researched sites, there was only one habitat, the KRIYA community, where two households share one outdoor toilet-bathroom facility, which is placed three meters distance from the homes. This residential community for 50 people offers cheap temporary housing options for youth singles and families up to the age of 40 years. https://auroville.org/contents/4828.

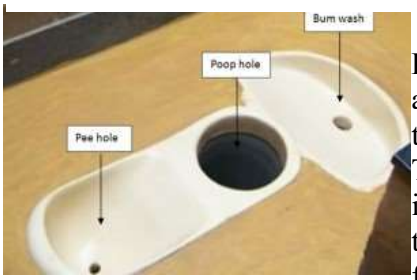
According to the JMP assessment, "Sharing implies a limited sanitation service." In Auroville, most households have private toilets, but some homes are equipped with shared toilets and bathrooms like in the KRIYA community. However, community members do not experience the shared bathroom as a limitation but as a free choice of a simple and sustainable lifestyle.

Figure 21: KRIYA homes with shared bathrooms

Adequate: *"Implies a system which hygienically separates excreta from human contact as well as safe reuse/treatment of excreta in situ, or safe transport and treatment off-site" (Normative Interpretation, UN, 2016)*

In all researched sites, the manure is safely stored. The diagram shows that most researched sites use septic tank facilities for excreta treatment and storage, but other storage versions are also in use.

Figure 22, Composting Toilets



Dry compost toilets have an excreta collector. In this method, solid and liquid waste is collected separately. Water cannot be mixed with the faeces, but a separate container is used for urine and washing. The faeces are mixed with sawdust, and once the collector is full, it is exchanged for an empty collector. The entire collector is then left to sit for decomposing in a safe storage location. As the final step, the decomposed manure is put in the sun for a few months of UV sterilization before reused as fertilizer. The fertilizer is used for trees and ornamental plants and not for edible plants to avoid any human health risks. Liquids are handled separately in dry compost toilets but are also often used productively. Some people experiment with urine, praising it as an excellent source of nutrients for pineapples, and some collect it separately for medicinal purposes. Dry compost toilets are usually located a little further away from homes and are built on a platform for practical reasons for easy maintenance. http://sacredgroves.in/?p=3612 .

Soak pits have a permeable wall, and liquid directly soaks into the ground while the sludge is emptied as needed. This method allows water usage in the toilet, but it is a very basic excreta processing way. It is only used in farm and forest settings. These toilets are flushed with water, but the toilets' waste does not get mixed with other wastewater but is collected in an independent soak pit under each toilet. Here the urine and faeces are mixed in the soak pit under the toilet. In such settings, there are several toilets, which are used alternately. Once the soak pit is complete, it would sit and naturally decompose undisturbed for months before the compost is emptied and reused under trees as plant manure. In Annapurna Farm, tree roots have grown into the soak pits, and the manure is directly absorbed. These soak-pits have not been emptied for more than a decade.

The **septic tank** is the very first step of a wastewater treatment system. In these systems, the toilet effluent is mixed with other effluents, such as kitchen or bathroom effluents. The mixed wastewater is primarily collected in septic tanks, and from there, it flows through multiple chambers and processing phases. In the septic tank, the sludge and water are separated through grating and sedimentation. The remaining wastewater flows into a soak pit or a chamber system and goes through a treatment process before being reused or soaked. The sludge remains in the septic tank until desludging happens. In most cases, the septic tank is located within the premises, but a few sites are connected to a joint wastewater treatment plant situated outside the sites. Two sites feed their on-site fresh or pre-treated wastewater overflow into the recently built semi-centralized wastewater treatment since 2019.

The combination indicates sites where multiple choices of toilets are present. These are the older sites situated in the Green Belt.

As for the treatment, all but one site indicated that EM is regularly poured into the toilet. EM, short for Effective Microorganisms, is poured into the toilet or added to the septic tanks to eliminate smell and enhance the natural decomposing process.

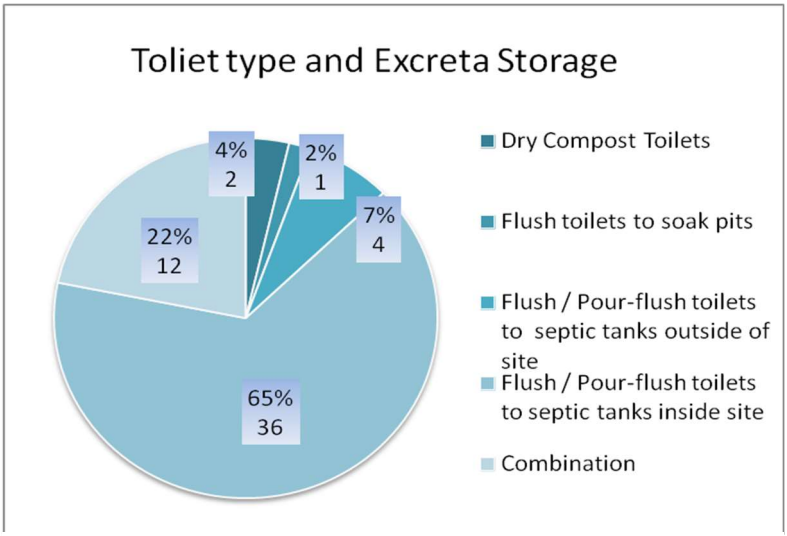


Figure 23, Toilet and excreta storage

It is available in Auroville in 2 forms. The denser "stock solution" can be further brewed on-site in barrels with added sugar and water to gain large quantities of EM. This brewed solution then added to the toilets, but it can also be used on the garden compost heaps. With this home brewing method, large quantities of EM can be reproduced for affordable costs, but the technique requires space and maintenance. There is another form named Activated EM Solutions available for purchase in the Auroville stores. This form is already brewed and diluted and can be directly used in sanitation facilities without further treatment. Both solutions are produced and sold in Auroville.

Table 2: Sales on biodegradable cleaning agents

LITRES	Sales Through Pour Tous Av shop	Direct Sales to consumers	Botanical Garden Sales
Activated EM Solutions	2079	2371	150
EM1 Stock Solutions	101,5	115,5	77,5

The above table shows the sales data of Eco-Pro from 2018. Approximately 4818,5 liter of EM product was sold in Auroville in 2018. That year the population of Auroville was 2814 people (adults and children), so 1.712 liters/residents EM was used in 2018.

Equitable: *Implies progressive reduction and elimination of inequalities between population sub-groups*

All public toilets were clean and in working condition. The surveyed public restrooms were equipped with both Indian and Western-type seats.

The varied toilets of dry compost and flushed types offer a choice. While flushed toilets are considered more convenient, dry compost toilets are considered more sustainable.

In two out of the 54 visited sites, the number of toilets was relatively small compared to the number of people using the site (one woman and one man toilet for 50 people, one discreet bathroom for 20 people). Both site management were aware of the problem and considered building extra toilets in the future.

The evolution of the Waste Water Treatment system will be described in more detail in the SDG6.3 description.

Sanitation*: Sanitation is the provision of facilities and services for the safe management and disposal of human urine and faeces*

Septic Tanks are connected toilets (as parts of Decentralized or Semicentralized Wastewater Treatment Systems (DEWATS):

In most sites, the excreta is collected together with the wastewater in a septic tank, the first tank of a wastewater treatment system. While the sludge remains in the septic tank, the wastewater overflows into a chamber system for further treatment. The sludge of the various wastewater systems is seen as an essential and potential fertilizer. The question of excreta placement is a complex one. The task is to deal with the hygienic hazard of wastewater on human health. If the wastewater is released into water bodies, it may destroy the local ecosystem, but it is a source of nutrients when released into the soil. In Auroville, all sludge and wastewater is released into the soil and not in surface water bodies. Since an earlier chart showed minor waterborne disease occurrence and microbial contamination in Auroville, the Auroville wastewater practices seem safe for human health.

The septic tanks are regularly desluged by the site management or by an authorized service.

From most sites, the accumulated sludge is desludged by an authorized Auroville service. The sludge is replaced on an Auroville forest site and decomposes undisturbed. The service does the transportation and desludging professionally, and the Auroville Forest Group members identify the sludge's final placement.

In 26% of the researched sites, the septic tank's sludge is managed on-site by the site management. These sites are designed and developed accordingly to have enough space and proper conditions where the sludge is composted. There is enough room for sundry the sludge for a 3-9 months-long process. The sun's UV effect does the final purification before the final product is mixed into the garden compost. However, this is used only under trees and not for vegetables as it is considered to have a human health risk when used on edible plants.

The decomposed sludge from soak pits and dry compost toilets is directly reused on the sites.

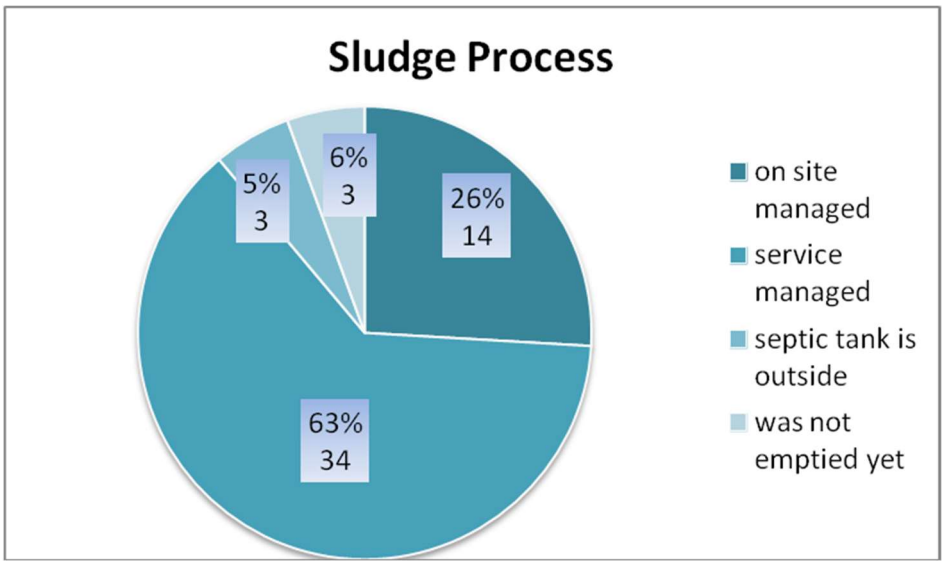


Figure 24, Sludge management process

Hygiene: *Hygiene is the conditions and practices that help maintain health and prevent the spread of disease, including handwashing, menstrual hygiene management, and food hygiene (Normative Interpretation, UN, 2016)*

All visited sites were equipped with handwashing facilities and soaps. These facilities were at the toilets, bathrooms, and eating places. In the visited schools, each classroom was also equipped with additional handwashing facilities.

Regular Health Inspection and training on food hygiene are guided by Auroville or Tamil Nadu authorities

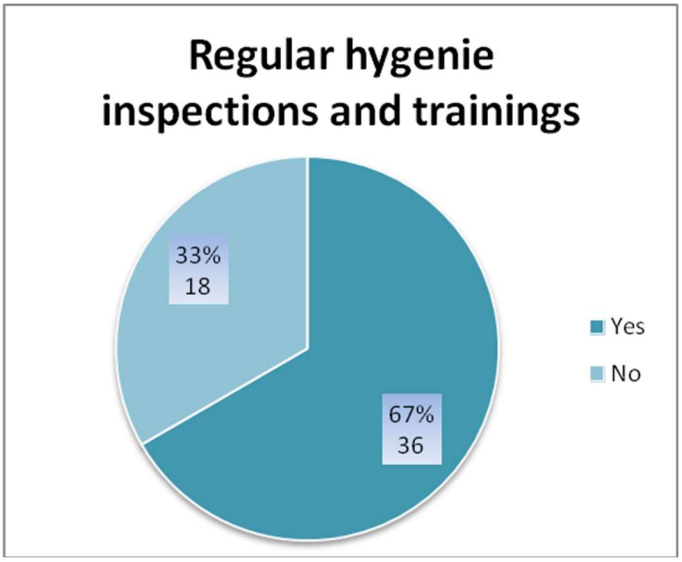


Figure 25, Hygenie inspection and trainings on sites

Food hygiene is a critical aspect of Auroville. Among the 54 researched sites, 30 (55%) were doing food processing or food serving. In all these sites, kitchens and food processing workshops were in clean condition during my visit. This achievement is partly due to the regular health inspections and training offered by the Auroville Health Service (AVHS).

AVHS regularly visits sites checks their hygiene, and offers educational training on hygiene and sanitation. This service is provided free of charge. https://www.auroville.org/contents/101

The data showed that not only the food processing units host regular workshops on hygiene. Besides AVHS, Eco-femme also offers training on menstrual hygiene for female staff and residents.

For all: *Suitable for use by men, women, girls, and boys of all ages, including people living with disabilities (Normative Interpretation, UN, 2016)*

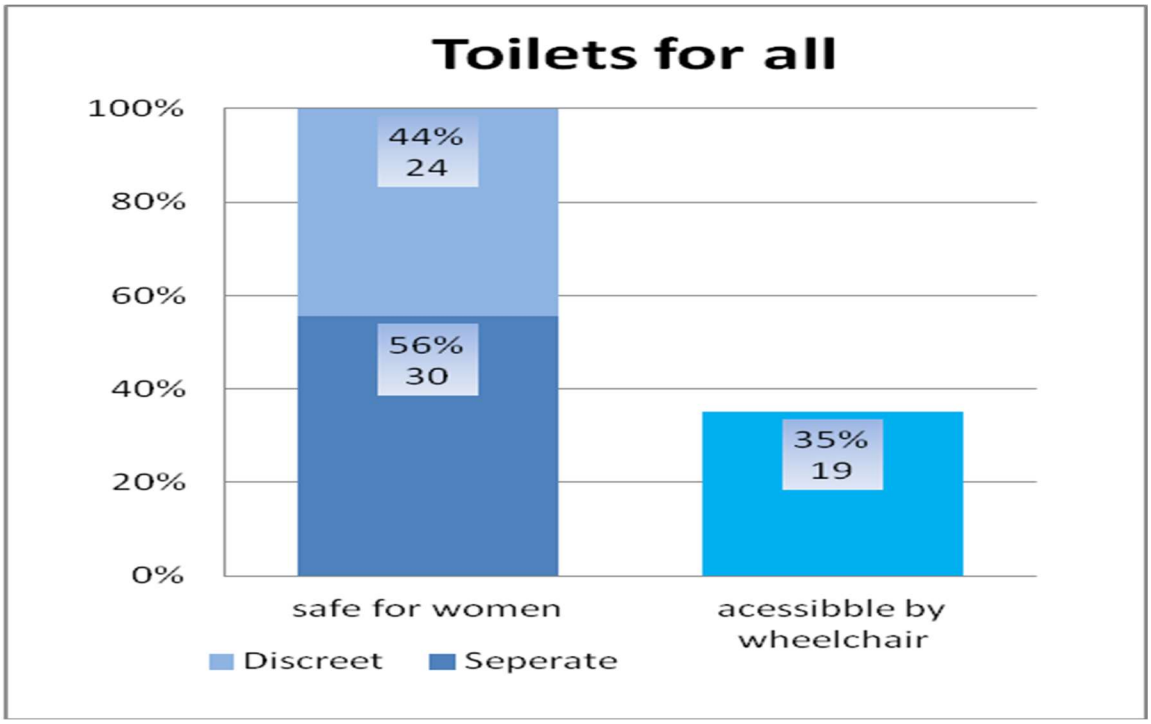


Figure 26, Toilet acessibility

All sites offer safe toilet use for women.

More than half of the researched sites had separate toilets for women and men. However, male-female toilets are not always separated. I inspected the unisex toilets and found that women can use them in a protected manner in all cases, i.e., lockable from the inside and visible proof from the outside. I named these discreet toilets.

One-third of the visited sites are equipped with toilets that are accessible by wheelchair. The rest of the interviewed sites are relatively rarely visited by people who need accessible toilets. As the manager of a catering venue said: “There is currently no need to create an accessible toilet, but as soon as our diners indicate their need, we will, of course, take steps to create an accessible toilet.”

End open defecation: *Excreta of adults or children are: deposited (directly or after being covered by a layer of earth) in the bush, a field, a beach, or other open area; discharged directly into a drainage channel, river, sea, or other water body; or are wrapped in temporary material and discarded (Normative Interpretation, UN, 2016).*

When I visited the research sites, I did not see any open defecation (ODF) traces. Some sites are situated next to fields used by residents in the vicinity of the site for ODF.

From the site visits and interviews, it is clear that most sites do not support open defecation practices, and special care is taken to provide adequate toilets for residents, workers, and visitors.

Five forest and farm site members are aware that one or more persons prefer to defecate in nature than in the toilet. However, this practice is done far from the water sources and faeces are always buried deep in the ground and never cause any inconvenience to the site members.

Paying special attention to the needs of women and girls: "*Implies reducing the burden of water collection and enabling women and girls to manage sanitation and hygiene needs with dignity. Special attention should be given to the needs of women and girls in 'high use' settings such as schools and workplaces, and 'high risk' settings such as health care facilities and detention centres." (Normative Interpretation, UN, 2016)*

I have already described the ratio of female to male toilets above. Although there are no separate men's and women's toilets everywhere, all toilets are designed to be safe and convenient for girls and women to manage their sanitation and hygiene needs with dignity.

All visited public toilet facilities were equipped with buckets where disposable pads could be dumped.

Some public toilets were equipped with additional shower-bathrooms and soaps, offering a bathing and washing opportunity for menstruating women.

<u>Ecofemme</u>

An important aspect of sanitation is menstrual hygiene and safety. In Auroville, private and public toilets are appropriate for women's safe and hygienic menstrual practices. This achievement is partly due to the work of Ecofemme. Ecofemme is a social enterprise that grew from social research on menstruation in 2010. The research showed a need to share safe menstrual practices and offer healthy, dignified, affordable, and eco-positive products. The project has been running since 2010, intending to produce hygienic menstrual tools that are safe for women and the environment. EcoFemme cloth pads are made of cotton & promote well-being through the menstrual cycle and are affordable and beautiful. Cloth pads can prevent thousands of non-biodegradable sanitary waste around the world each month. It takes 500+ years for a plastic pad to decompose. Eco Femme has sold and distributed 680.000 pads, saving 51 million (5.1 crores) disposable pads from landfill until January 2020. The enterprise gave free training to
44.000 adolescent Indian girls on menstrual hygiene and waste management.

Disposal of menstrual waste: The inspected toilets were equipped with bins. Ecoservice collects separately the menstrual waste, at an extra charge, and disposes of it on the landfill. Some sites burn and then dispose underground.

And those in vulnerable situations: Implies attention to specific WASH needs found in 'special cases' including refugee camps, detention centres, mass gatherings and pilgrimages (Normative Interpretation, UN, 2016)

Auroville is visited by 1 million tourists a year and also regularly hosts mass events such as the Marathon, where drinking water and hygiene are properly provided.

DISCUSSIONS

Target achievements:

The normative interpretation divides the target into eight parts that can be well interpreted to Auroville's aims and activities.

Sanitation and hygiene are promptly addressed in the researched ecovillages.

The local systems store excreta safely. Local services provide safe collecting, handling, and replacement of toilet sludges and sanitation waste.

The use of composting toilets has appeared in all four communities. It is an environmental and water-conscious toilet type. However, these compost toilets are optional and not obligatory.

Women and men can safely use the toilets. There are separate women, and men public restrooms. Some public toilets are unisex, which are lockable from the inside and visible proof, thus safe to use for ladies.

Some public toilets are accessible with a wheelchair. These are situated in venues where the wheelchair is used. Such as the Deepam school of differently-abled children in AV.

The menstrual hygiene needs of women are strongly reflected in AV. Some workplaces are equipped with bathrooms, showers, and attached laundry facilities. EcoFemme social enterprise provides training and menstrual cloth pads. It also campaigns for the use of eco-friendly menstrual products. In the ecovillages, buckets are placed in the public toilets where disposable pads can be safely placed.

Open defecation is present in the area of AV, but it does not occur within AV sites.

The Covid pandemic drew attention to the importance of handwashing. The ecovillages' public bathrooms, toilets, classrooms, workplaces, and dining rooms are equipped with handwashing facilities with soaps. Primarily biodegradable soap is used.

Hygiene protocols are closely monitored. The hygienic monitoring system is essential due to the communal canteens, catering, and food production. Regular training and well-developed hygiene monitoring systems have evolved in the communities.

Monitoring and indicators:

Many of the 26 indicators are suitable for monitoring ICs. However, the JMP addressed additional vital questions in its monitoring that unfortunately do not appear in the measured indicators. I added 45 further questions to the monitoring collection.

The UN indicator 6.2.1 defines sanitation services as limited if several households use shared toilets or bathrooms. The co-housing type homes in the examined ecovillages share the toilet- bathrooms among two households. Residents experience this not as a limitation but as a sustainable solution.

Another shortcoming of the monitoring indicators is the lack of focus on non-degradable sanitary waste. In Los Angeles (VLR), KRV, and AV, the non-degradable sanitary waste appeared as a problem. Various actions were taken to tackle this issue, such as awareness campaigns and technological solutions like inserting grids in pipes and placing waste bins in toilets.

Conclusions: The SDG6.2 target and most of its indicators can be applied to refer to and monitor the ICs' aims and activities. Additional targets and indicators are needed to include the application of compost toilets and the management of non-degradable sanitation waste. The sanitation practices category needs enlargement, including the co-housing type shared toilet-bathrooms as non-limited.

IV.4. SDG6.3

By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally."

***Improve water quality**: Implies achieving adequate quality of receiving water bodies so that they do not present risks to the environment or human health. (Normative Interpretation, UN, 2016)*

AV: Receiving water is defined as an ocean, stream, river, pond, lake, or another such water-body into which treated or untreated wastewater or effluent is discharged. Part of Auroville is located on the seashore. There are some natural and artificial temporary water bodies during the monsoon that collect and guide the rainwater. Other than that, there are no permanent natural water bodies in Auroville.

None of the researched sites allows any wastewater to flow into the sea or rainwater channeling and catchment systems. All wastewater is either being reused for irrigation or infiltrated into the ground. Thus, the quality of surface waters is not affected by wastewater pollution, but it can affect groundwater quality. Wastewater is treated to avoid groundwater pollution. The treatment methods will be described later.

***Reducing pollution**: Implies minimising the generation of pollutants at source and reducing the discharge of polluting substances from point sources (for example, wastewater outlets from economic activities and households) and non-point sources (for example, urban and agricultural runoff) (Normative Interpretation, UN, 2016)*

According to my research, five types of pollution can enter surface or subsurface water bodies.

1. Wastewater Outlets: wastewater polluting substances of activities and households
2. Agricultural Runoff: pollutants generated in agriculture
3. Urban Runoff: dirt from transport vehicles, from machines
4. Industrial Pollutants: unproperly treated hazardous chemicals
5. Contaminants from improperly treated/stored waste

In the research, I dealt with all five types of pollutants; in this subchapter, I present relevant information on 1-3 pollutants, and in separate subchapters, I will introduce my findings on points 4 and 5.

Wastewater Outlets

Pollution may occur from cleaning agents and beauty products. It is therefore important to emphasize that biodegradable cleaning products are trendy in Auroville.

Households, institutions, and services are using locally manufactured biodegradable soaps and cleaning products. The cleaning agents' raw materials are soaptree seeds, bamboo ash, and EM (Effective Microorganism). These chemicals clean well but can be stored for a relatively short time, and liquid cleaners should be used within one month. In the local stores, biodegradable cleaning products are sold in bulk. It can be recharged into personal reused bottles, reducing plastic waste accumulation. Customers can purchase as little as 100ml of liquid soaps.

I am aware of nine Auroville units that manufacture biodegradable cleaning products. Maroma,

MGEcoduties, Natura, Mereville, Avatar, Imagination, Bamboo Center, Solitude Farm, Eco-Pro. There are regular DIY workshops on making cleaning and beauty products from natural materials. A popular locally brewed and relatively cheap product is the EcoPro company-made EM-based cleaning products. These are used for gardening and sanitation purposes. I have received some information on Eco-Pro company's 2018 financial year sales on EM products. This information was earlier shared in Table 2

The following diagram shows the researched sites' use of biodegradable cleaning products.

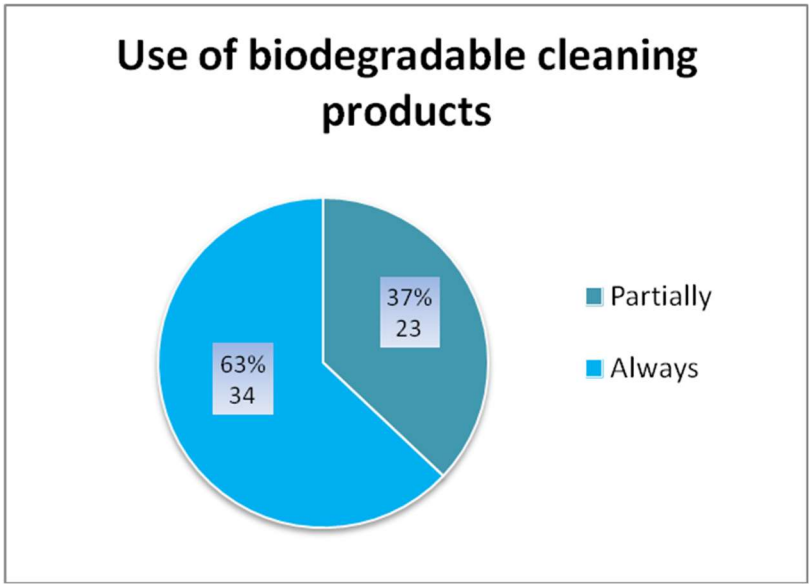


Figure 27, Use of biodegradable cleaning agents per researched sites

While these are popular products, not all sites use biodegradable products only. Some respondent questions the disinfection effects of the products and therefore use additional chemicals. Some respondents find biodegradable products far more expensive than commercial cleaning products and choose to use additional conventional products for economic reasons.

Urban runoff:

One primary type of urban runoff pollution is vehicle pollutants. Cars and motorbikes are parked under roofs which lowers the risk of contaminants being washed away by the rain.

Numerous services offer community transportation in Auroville. The central Transportation Service is responsible for running the school buses and public transport. The manager explained that as regular maintenance, the vehicles are checked daily for leakages. Vehicle washing happens weekly in a governmental service park, where the wash water is collected and treated to avoid environmental pollution.

Agricultural runoff

Regarding the farms, only organic farming happens; some are state-certified organic farms, and some are not. Only natural and organic products are used for agriculture and gardening like Neem oil or EM products in all visited sites. There are numerous recipes for farms and gardens to brew their natural sprays to enhance the flowers or to weaken and deter the pests.

Eliminating dumping: *Implies ending all inadequate disposal of waste (solid and liquid, for example, leachates from poorly managed solid waste) (Normative Interpretation, UN, 2016)*

While visiting the sites, no plastic rubbish was observed in the sites. Some sites are neighbors to rainwater catchment channels, and regularly clean and maintain these channels, as many channels, running through the neighboring villages, are loaded with rubbish.

To ensure that Auroville's waste has as little impact as possible on the environment EcoService manages solid waste. The residents separate waste on-site, and an EcoService team collects it, and another team processes it at a sorting shed. Waste is then either sold to recycling dealers or landfilled at the Auroville landfill. About 72% is recycled and 28% landfilled.

Ecoservice takes an active lead in achieving a zero-waste city. It raises awareness among the citizens and the schools on responsible waste disposal. Further info: https://auroville.org/contents/789

WasteLess, a non-profit research center, has created innovative education tools and programs for Sustainable Waste Management, such as Garbology 101, kNOw Plastics, and 'Pick it Up'. It has collaborated with the International Start Upcycling project. Their educational programs focus on developing healthy consumption habits from an early age. Further info: https://auroville.org/contents/1911

In local stores, many products are sold without packaging. In a 2006-2009 project, smallholders cooperated and jointly bought biodegradable plastic into which their products were packaged.

Minimising release of hazardous chemicals and materials: *Implies reducing the generation, use and discharge of hazardous substances, as defined and listed in the conventions of Basel, Rotterdam and Stockholm (Normative Interpretation, UN, 2016)*

The first step to efficient wastewater treatment is to reduce the hazardous chemicals entering the wastewater. Out of the 17 categories of highly polluting industries potentially hazardous to water safety, two can be found in Auroville. The Auroville Paper Factory, and the Colours of Nature fabric dyeing unit. However, both plants work exclusively from organic raw materials. Whilst their technology and products are more expensive than the products of companies using harmful substances, the wastewater generated is free from chemical pollution. It can be directly reused for irrigation, while the sewage sludge is reused as compost to replenish plant nutrients. During site visits, I found that both companies have a highly sophisticated wastewater treatment system.

Auroville Papers started in 1996. It is a creative enterprise that crafts handmade paper out of cotton rags, vegetal fibers, and recycled paper. It produces stationery, jewelry, flowers, and a great variety of works of art. It uses only organic material and has a firm commitment to making ecologically sound products. Further info: https://www.aurovillepapers.com/products/

The Colours of Nature was set up as a research unit in 1993. It works with the ancient traditions related to natural dyes, mainly with the fermentation of indigo tree leaves. It also explores the cultivation, harvesting, and processing of its colorants. The company uses the same water in its vats since 1993, and no water is ever wasted. The company uses only organic materials, and the by-product is valuable compost in farming. The company prepares 500 kg of naturally dyed fabrics and 2000 pieces of readymade garments per month. It is a senior member of the Tamil Nadu Pollution Control Board (TNPCB). The Advanced Environmental Laboratory regularly monitors the quality of the wastewater effluent. The data shows no significant pollutants in the wastewater. The TNPCB authorizes the Colours of Nature unit to discharge a maximum of 1.8 KLD of treated wastewater on its land, and another 5.0 KLD of treated wastewater on irrigation land daily. As written in the TN Pollution Control reports (Annex). Further info: https://thecoloursofnature.com/natural-dyes/at-the-colours-of-nature/

Halving the proportion of untreated wastewater: *Implies halving the proportion of wastewater that is untreated, generated by households and all economic activities (based on International Standard Industrial Classification (ISIC) Rev. 4); some economic activities are of special relevance due to high wastewater generation, including agriculture, mining and quarrying, manufacturing, electricity and sewerage. Treatment implies any process for rendering wastewater fit to meet applicable environmental standards or other quality norms; treatment can be categorized into primary, secondary and tertiary treatments (and further by mechanical, biological, and advanced technology treatments). Discarded water that is no longer required by the owner or user, including discharges to drains or sewers for treatment or direct discharges into the environment, as well as water reused by another user without further treatment (Normative Interpretation, UN, 2016)*

The Auroville community has been experimenting with small-scale wastewater recycling systems since the mid-eighties. Various treatment systems were built, experiences were gathered, and the operating skills of plants improved. Due to the lack of expertise, the first experiments were learning possibilities with many errors. After contacting experts abroad, the wastewater systems shifted to planted filters. These were popular in the nineties and served well but needed ample space. From 1995 to 1998, Auroville participated in a EU funded project on Decentralised Wastewater Systems (DEWATS). These systems are widely used in Auroville today, as shown on the diagram below.

Most Auroville wastewater is going through multilevel biological wastewater treatment systems. Except for some cases where pumps are being used for aeration and irrigation, the systems are non-mechanical. The water flow is established by gravity.

Figure 28, Vortexes in Auroville

Many treatment systems include a vortex ventilator, a root zone cleaning, and buffer tank sedimentation. The resulting wastewater is clean and odorless enough to be stored near buildings as an ornamental pond or used to irrigate parks. Some systems contain a polish pond where the treated wastewater is stored. These polish ponds are filled with fish, function as wetlands, and are home to water birds.

The wastewater treatment systems are of different capacities. Some are suitable for one household, others for multiple families, institutions, and bigger units. The largest is a semi-central system that has been in operation since 2019. This system is currently treating the wastewater for eight residential communities. It has 450 people capacity, which has not yet been reached. Several individuals and communities effectively reuse the returning treated water for irrigation purposes for trees and ornamental plants. Water that is not used is being captured in four tanks of 50 cubic metres, located in Mahalakshmi Park. Situated close to the Matrimandir, this water can be used to water the gardens there.

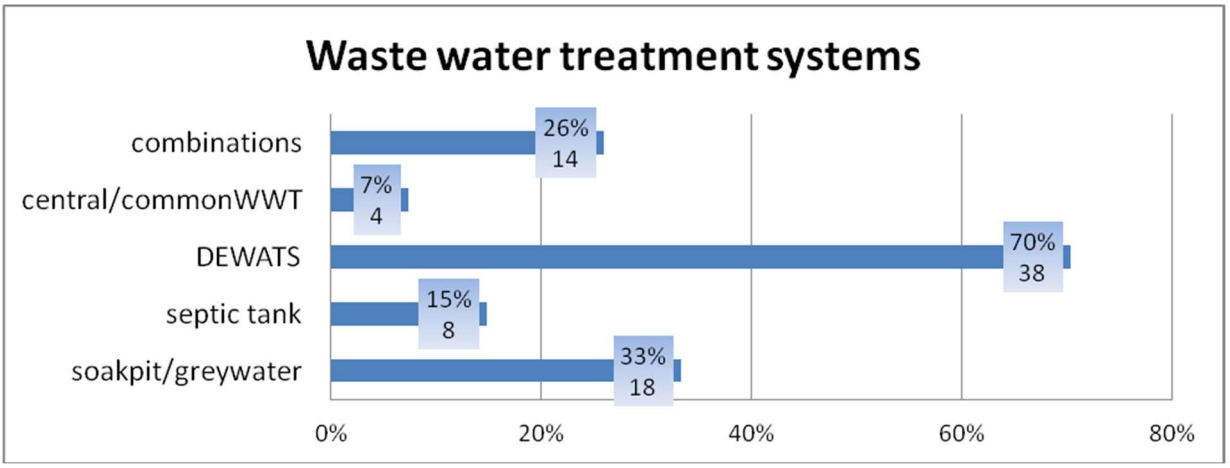


Figure 29, Wastewater treatment systems of the researched sites

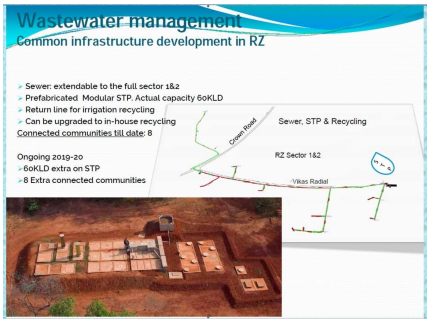


Figure 30 Centralized wastewater treatment system

Increasing recycling: *Implies increasing the on-site reuse of water within the same* establishment or industry *(Normative Interpretation, UN, 2016)*

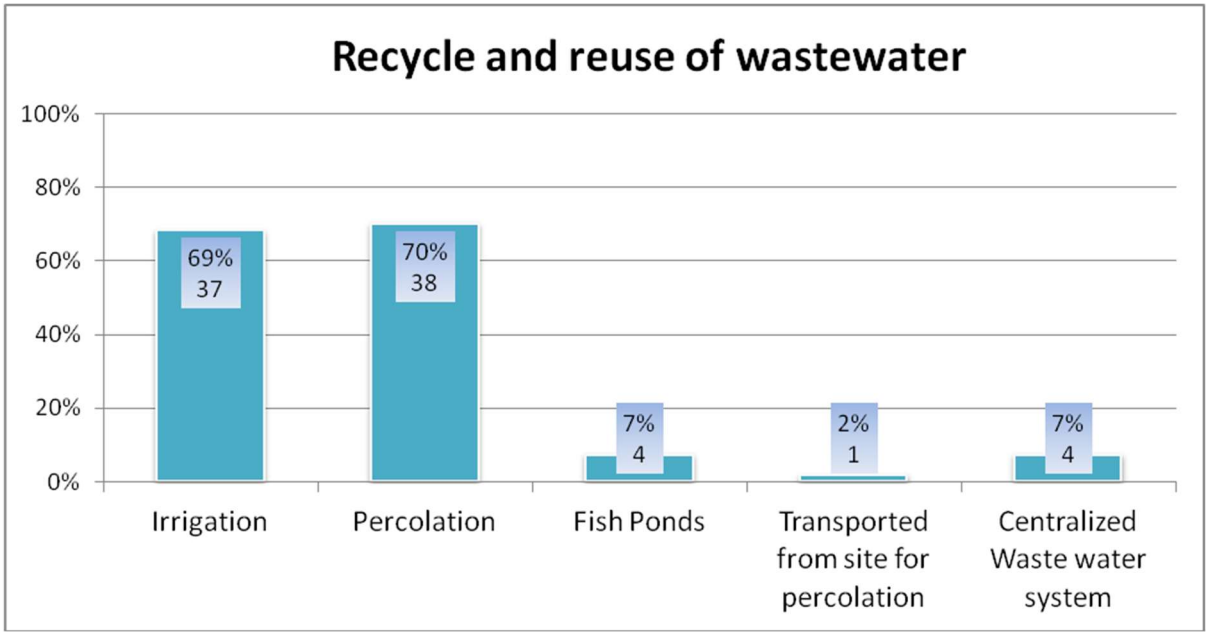


Figure 31, Recycled and reused watstewater on researched sites

Wastewater recycling for irrigation is prevalent. The greywater is fully or partially separated in 43% of the researched sites. Partial separation means that the site has a wastewater treatment system where the bathroom wastewater is mixed, while the kitchen water is collected separately. In 17% of the researched sites, the toilet waste is fully separated from the bathroom and kitchen waste. Greywater is fully separated in communities where compost toilets are used only. Greywater comes from kitchens, and should not contain microbial contamination, but may contain valuable organic material that replenishes soil nutrients. All kitchen greywater is used for irrigation. With the use of biodegradable cleaning agents, such water is recyclable for irrigation without any treatment. The permacultural system suggested Banana Circles or other circle kitchen gardens are popular. These are placed near the kitchens, so greywater directly flows on them.

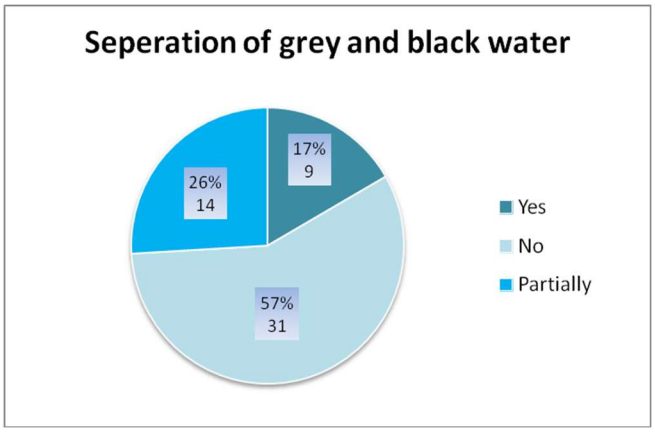


Figure 32, Seperation of Grey/Black water

and safe: *Implies water has undergone sufficient treatment, combined with non-treatment barriers to protect human health, for the intended use (as described in the 2006 WHO Guidelines for safe use of wastewater, excreta and greywater) (Normative Interpretation, UN, 2016)*

Apart from the greywater treated wastewater is also recycled or reused for irrigation purposes, but to avoid health risks only for trees, orchards, or grasses, and not for edible plants. Many researched sites recycle the wastewater on-site for irrigation purposes. Separate tanks and pipe systems ensure that the wastewater can be recycled or reused for irrigation purposes without affecting drinking water safety.

Reuse: *Implies wastewater supplied to a user for further use, with or without prior treatment (for example, use of household wastewater in agriculture), excluding the recycling of water within the same establishment (Normative Interpretation, UN, 2016)*

The Semicentralized wastewater system's treated wastewater is reused for irrigation. A pressurized return line allows the connected habitats to make use of the treated wastewater for irrigation purposes. The remaining wastewater is used for irrigation in the parks of Auroville.

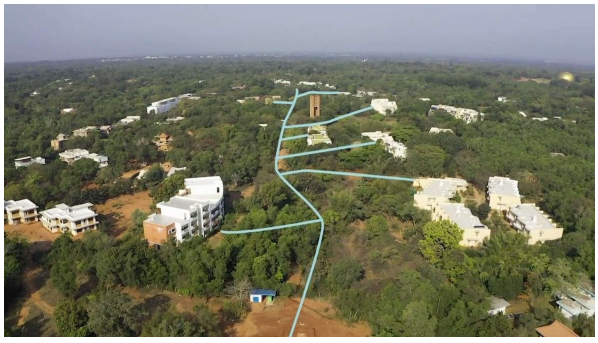


Figure 33, Central WasteWater Treatment System returning pipeline of treated water

Globally: *Implies increased recycling and safe reuse at the global scale, allowing for differentiated efforts at the national and regional scales, focusing efforts on water-scarce regions (Normative Interpretation, UN, 2016)*

Auroville hosts 1.000.000 visitors in a more extended period, but most visitors are between December and March. Most of the visitors spend a short time in Auroville and reside around the Visitors Center. Places experienced difficulties in treating the visitors' non- degradable toilet waste.

Although the use of environmentally friendly chemicals is recommended for the efficient operation of microorganisms, and only such cleaning products are available at the local store, in many cases, visitors come with their less environmentally conscious cleaning products.

While the global targets primarily focus on treating human faeces and urine, non-decomposable wastes contribute to the challenge of handling toilet wastes. Questions regarding toilet rubbish are included in the JMP questionnaire. Still, there was no reference to toilet rubbish in the normative interpretation of the target parts or among the listed indicators.

Some visitors used the toilets improperly and clogged the wastewater treatment plants by throwing plastic waste down the drain. Wet wipes and menstrual pads accumulated in the settler and blocked the grate shaft, which had to be removed mechanically. One solution is to place suitable rubbish bins with awareness posters in the toilets. This practice reduced the load, but the problem still persists. Additional built-in grids were added to the systems to grasp the plastic waste.

In Auroville, most sites apply awareness campaigns on the proper deposition of non-degradable toilet waste. This includes Multilanguage posters for the visitors and training for the workers.

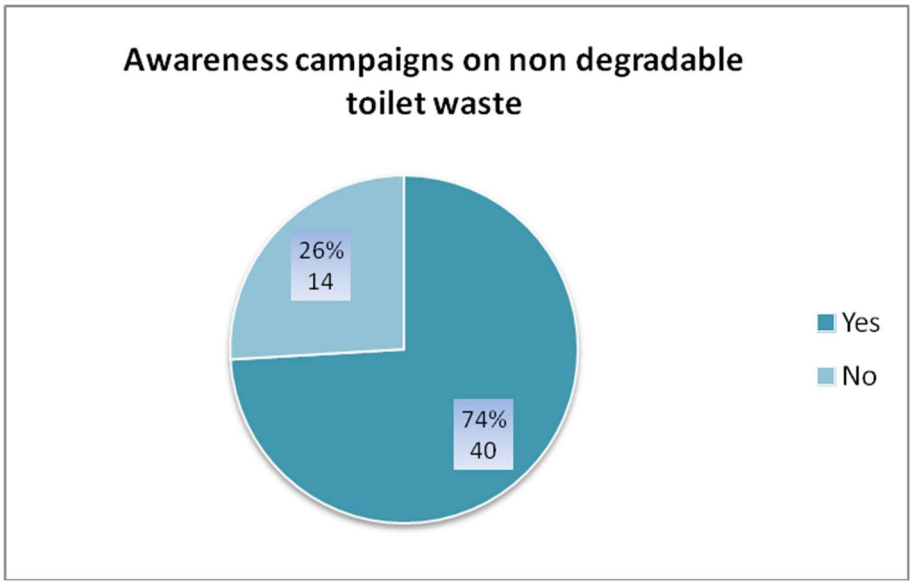


Figure 34, Non degradable toilet waste wawreness campaign on research sites

DISCUSSION

Targets achievement:

The normative interpretation divides the target into eight parts, all of which are well reflected in Auroville.

The studied communities do not allow wastewater to enter into receiving water bodies. Beyond the environmental reasons, wastewater itself is seen as a valuable resource. Its' reuse influences water scarcity, and water resources are limited in the researched sites. The production and storage of water require a lot of energy, and a partial renewal is achieved when the wastewater is irrigated on energy plants.

The most common recycling is watering with proper terms of hygiene. The generated wastewater is discharged into the forest or on ornamental plants in parks. Care is taken to ensure that wastewater does not contain substances that are toxic to plants. Only organic agriculture is practiced, and industrial units use only organic material to avoid toxic substances entering the wastewater. Community shops sell biodegradable cleaning products, and these are used in public venues and private households.

A simple method, the separation of grey and black water, is done in the communities. AV uses greywater for irrigation. Circle gardens are placed next to the kitchens, and water from the kitchen sink flows directly on them.

Besides, various wastewater treatment systems are in use.

An ornamental pond can contain the wastewater after proper treatment and ventilation. In AV, the polish ponds are located in the parks and gardens. In both cases, the wastewater lakes are aesthetically pleasing and contribute positively to biodiversity as many animal species find a home and feeding place in them.

To reduce waste, the communities compost degradable waste, selectively collect garbage, and pay attention to recycling. The local shops sell goods without packaging, and there are awareness campaigns to create conscious consumer habits.

Monitoring and indicators:

Many of the 48 found indicators suits well the ICs. I added 31 questions to the monitoring collection.

There is a lack of focus and indicators on biodegradable cleaning products, greywater separation, and consumer habits. I miss an emphasis on 100% of wastewater retention, contributing to local water security.

Conclusion: The SDG 6.3 target and most of its indicators can be applied to refer to and monitor the ICs' aims and activities. Additional targets and indicators are needed to include biodegradable detergents, greywater separation, consumer habits, and wastewater retention.

IV.5. SDG6.4

Target 6.4: Increase water use efficiency and ensure freshwater supplies. UN definition: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

By 2030, substantially increase water-use efficiency: *Implies maximizing the productivity of economic activities while minimizing their water use(generating more output per input of water, including by reducing water losses); closely related to the concept of sustainable production and consumption (Normative Interpretation, UN, 2016)*

Water use efficiency is measured by the GDP/water m^3 indicator. Monitoring this indicator in Av or KRV is difficult as there is no data on all water consumption. It is possible to collect data for some sites or projects.

Table 3: Water use efficiency in two Auroville units

Water use efficiency:	GDA/yearly Water Use
Svaram:	**11,413 RS/ m3**
Colours of Nature:	**2,403 RS/ m3**

The above table compares the 2019 data of Svaram and Colours of Nature companies with approximately the same nr of employees. Svaram is more water-use efficient by this indicator. This indicator cannot express all the efforts that the Colours of Nature made for sustainable water use, as introduced under the SDG6.3 chapter.

across all sectors: *All economic activities (based on ISIC Rev. 4 categories); some industries are of special relevance due to high water use, including agriculture, mining and quarrying, manufacturing, electricity, and water collection, treatment and supply (Normative Interpretation, UN, 2016)*

Due to groundwater over-extraction, water stress is present all over. The situation is predicted to become even worse due to population growth and climate change.

Today 70% of humanity's water consumption is used in agriculture.

Various alternative agricultural methods and proper water management allow Auroville to produce food even in the most challenging weather conditions. Laying hens, dairy cows, and work bullocks are kept, and various plant' cultivation occurs on Auroville's 22 farms. Each farm is organic and utilizes only environmentally friendly pest and disease control products such as Neem tree extracts or EM. The combination of several methods is used in Auroville to reduce the water consumption of agriculture.

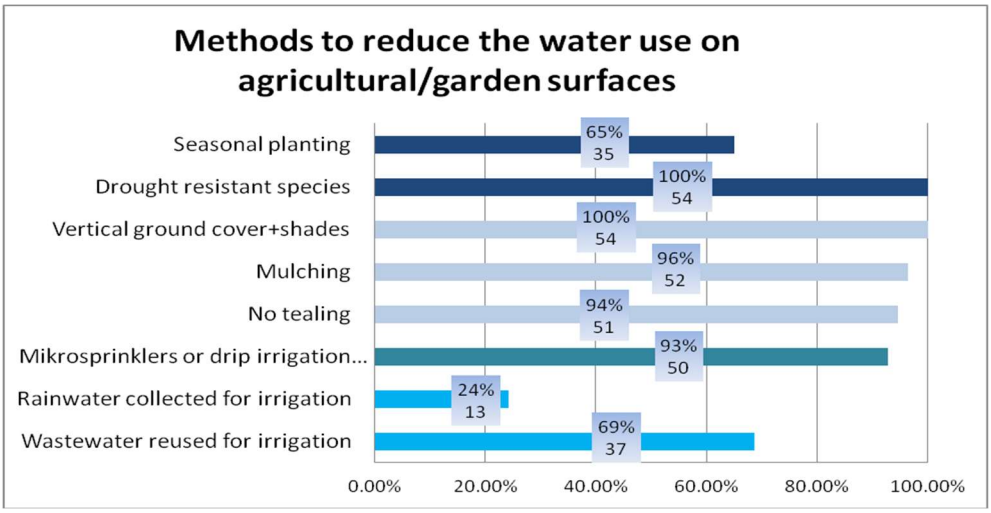


Figure 35, Water use efficiency in agriculture

A combination of different irrigation methods is available for various crops. Rice is grown with flood irrigation during and after the monsoon season. Annapurna farm's , 50000 m3 rainwater reservoirs are storages for the rice fields, and only rainwater is used for the flood irrigation of rice plantations. The reservoirs allow Annapurna Farm to prolong its rice plantation period.

Mulch-covered drip irrigation systems preserve the soil moisture in vegetable gardens and orchards. In an experiment at Buddha Garden, smart technologies are incorporated into the micro-irrigation system. The quantity of daily water use is determined not only by the plant species but also by the daily data on soil moisture and weather forecast. This method,

Figure 36 Buddha Garden vegetable bed *Mulching and drip irrigation is combined in the vegetable garden. Copyright: Auroville Outreach Media*

combined with mulching, maximizes the water efficiency of the farm.

The ground is not plowed. Most farms practice permaculture, multi-layered farming or plant associations, and combinations that allow groundcover plants to protect the soil from evaporation. The taller species give comfortable shade. This way, the plant species support each other and grow well while using the available water more effectively.

Farms follow the seasons by growing crops seasonally. Crops that require a lot of water, like rice, are generally produced during the rainy season. While in the drier seasons, the local drought-resistant crops are grown. In Auroville's early years, indigenous plants were still grown in local villages. Today, the seeds from those plants are scarce. Aurovilians have collected and preserved the seeds of local cereals such as samai, kombhu, varagu and ragi and have consistently saved the seeds in private and community seed banks. These crops produce smaller yields than rice, but they require less water, grow well during dry seasons and drought, and have excellent nutritional content. In the farms, priority is given to growing local, indigenous plants.

Garden vegetables have also been introduced since the 1990s. By collecting and replanting the seeds of imported vegetables and fruits, new varieties have been developed that adapted to the local conditions.

As the trees grew, their shade made it possible to lengthen the production period and grow vegetables and fruits for a more extended portion of the year. In this vertical horticulture concept, the heat-sensitive vegetable gardens are located so that only the morning sunlight reaches them, while during the afternoon, they are protected by natural shade. Experiments are underway in several Auroville forests to plant and propagate tree varieties suitable for food and biofuel production. Ayurvedic medicinal herbs are successfully grown in the woods and are used as nutritional supplements and medicines. Herbs are also used to produce soaps, detergents, and environmentally friendly sprays for agricultural pest and disease control.

The methods of hydroponics and spirulina farming are also explored in Auroville. These methods successfully produce green leafy vegetables.

There have been several attempts to introduce Aquaponics systems in Auroville. These systems require little water and provide a secure crop under extreme weather conditions. Experiments are still on their way; there have been minor successes, especially in lettuce production.

Figure 37, Spirulina Farm in Auroville

The number of spirulina farms in Auroville is gradually increasing. Spirulina is a freshwater alga containing a high concentration of micronutrients and is labeled as a superfood due to its extremely high nutritional value. It is said that spirulina is the future food, and NASA is experimenting with it as a fundamental source of nutrition for space travel. Spirulina farms require relatively little water and little space for production, and the plants grow well in brackish water. The predicted sea-level rise may increase spirulina farms' popularity along the coasts (Aurospirul, 2017).

Beyond production, it is equally crucial that crops are valued & consumed. Some local restaurants prioritize healthy local rainfed crops on their menus. The local Foodlink connects the customers and the farmers with its services, while the Solitude Farm Community Supported Agriculture system offers its members food boxes. With these healthy consuming habits, local people support the farmers in practicing sustainable, water-saving food-growing methods.

It is estimated that approximately 20 % of all water is used for industrial activities.

Small-scale handicrafts are present in Auroville. As written in the hazardous waste chapter, the Paper

Factory and Colors of Nature Dying unit uses only organic materials. Their wastewater is fully reused on neighboring agricultural lands or percolated into the ground. Colours of Nature has additional plans to change its operational system and further reduce its water consumption.

AquaDyn industrial unit manufactures water purifiers. Their Reverse Osmosis system produces byproduct, a mineral-rich "grey" (industrial) water, which is directly reused in bathrooms and plant irrigation.

It is estimated that approximately 10% of all water is used for domestic purposes.

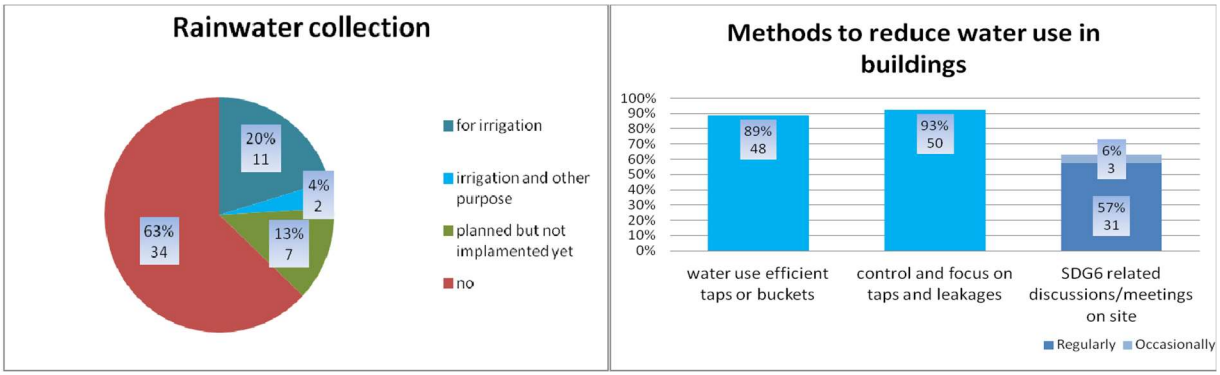


Figure 38, Rainwater collection and water use limitation on research sites

Some sites (only 24% of the researched communities) collect rainwater in non-permeable tanks to reduce groundwater consumption. They primarily use the collected rainwater for irrigation, just like treated wastewater, as explained in chapter SDG6.3. Some explore Japanese- style dry gardens around the houses to reduce water use further.

In most institutions and public bathrooms, water use efficient taps and toilet flush methods are used. These methods may vary site by site. In some schools, the children use the buckets with water for precleaning their dishes before using the running water taps. Or buckets are used to clean the kids' feet instead of running water. In some sites, the bathrooms are equipped with buckets instead of showers.

Some sites changed their toilet flush system from bucket to reduced toilet water tanks with half or full-tank flush options. Even dry urinals were tried out at the Visitors Center, but it didn't work.

A laundry service has operated in Auroville since 2017 with water-use efficient machines, and some of the researched sites regularly use their service. The popular floor cleaning flooding techniques are changed to moping. Water-efficient devices were built in the community kitchens and for residential use, such as faucet aerators.

In the Transport Service, vehicles are dry cleaned daily and washed with running water only once a week, to reduce the water need. Similarly, the Red Earth Riding School uses wet sponge cleaning instead of daily bathing the horses. Some places have small pools for kids during the hot season. These pools are situated in a higher plane, and all its water is reused for irrigation.

Most sites put extra energy into controlling dripping taps and leaking pipes. Faucet aerators are placed on community kitchen taps. Cytadines check the water meter daily to detect potential leakages immediately. Auroville Water Service, a semi-centralized water supplier, has changed its pipelines. It had measured 30% of water loss in 2000, which has reduced to almost 0% water loss since installing their new HDPE pipes.

Beyond the technical solutions, water-saving is a reoccurring theme on the site meetings and discussions.

and ensure sustainable withdrawals: *Implies that water withdrawals do not lead to permanent depletion of water bodies, taking environmental water requirements into account (Normative Interpretation, UN, 2016)*

A survey in 2005 counted 6137 wells in the close vicinity of Auroville and measured a 54-meter groundwater level drop in 30 years, caused by its over-extraction. Experts estimate that by today the number of wells has tripled since 2005.

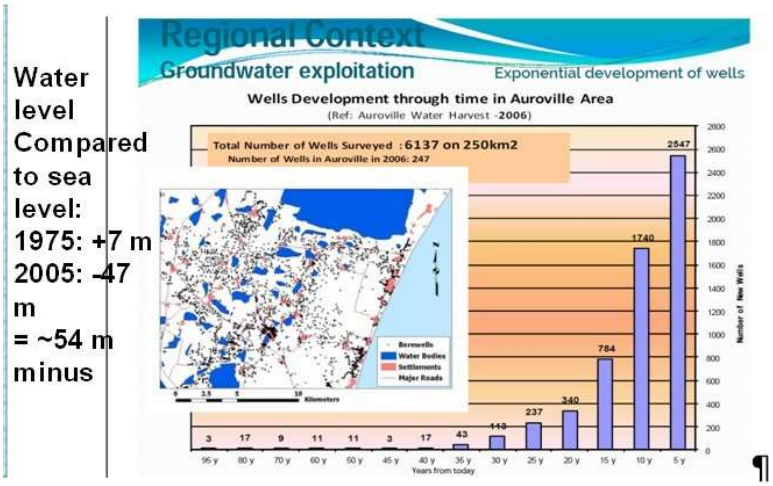


Figure 39 Groundwater level data

The Auroville-GIS group monitors Auroville wells, regularly reporting water level depth on an open-access webpage. There is a substantial fluctuation in the water level, and throughout the decades, the water level is noticeably dropped. Well drilling is not regulated in India but is subject to a permit in Auroville. Farmers, for example, must first apply for a permit from the Farm Group and the Town Development Council. These usually do not allow well-drilling to deeper water layers but encourage farmers to build rainwater reservoirs, similar to the Annapurna farm.

and supply of freshwater: *Naturally occurring water with a low concentration of salts, or generally accepted as suitable for abstraction and treatment to produce potable water (to compare with brackish and marine water – defining salinity concentrations varies among countries); the definition of inland water resources includes both freshwater and brackish water, categorized as surface water, groundwater and soil water (Normative Interpretation, UN, 2016)*

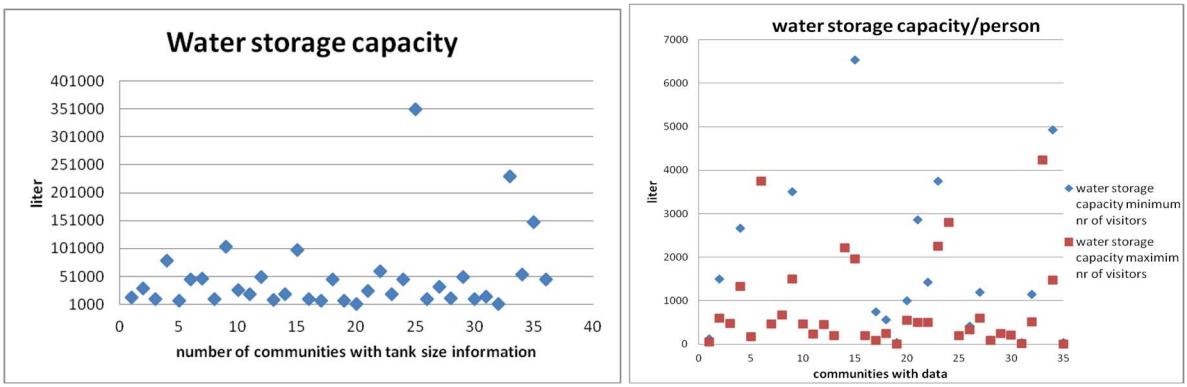


Figure 40 Water storage capacity in Auroville research sites

As shown in the diagrams above, Auroville sites use various capacity water tanks. Six of the researched communities do not have any water tanks, only inline water from the semi-centralized water supply system. Thirteen communities had tanks but did not know the size of their tanks. If the sites knew their water tanks' capacity and would follow up on their recharge, we could estimate the water use without an installed water meter.

From the available data, I have calculated the water storage capacity/person. For visibility reasons, I took out the highest number, Sacred Groves, which has 11667 liters/person storage capacity when the least people are on site.

The figure shows that water reserve per capita is more than enough for most sites when a minimum of people are on site. The water reserve seems to be remarkably low, with the maximum number of visitors. The Visitors Center has 45.000 liters of water storage capacity, but the number of visitors can reach 8000 people/day. On such days the water storage is calculated to only 6 liters/person. In reality, the tanks are constantly refilled from the wells, and the visitors only stay on site for a short time in a kind of constant flow.

to address water scarcity: *The point at which the aggregate impact of all users impinges on the supply or quality of water, to the extent that, under prevailing institutional arrangements, the demand by all sectors, including the environment, cannot be fully satisfied; physical water scarcity prevails when more than 75% of available water resources is withdrawn; economic water scarcity prevails when malnutrition exists, although less than 25% of available water resources is withdrawn (Normative Interpretation, UN, 2016)*

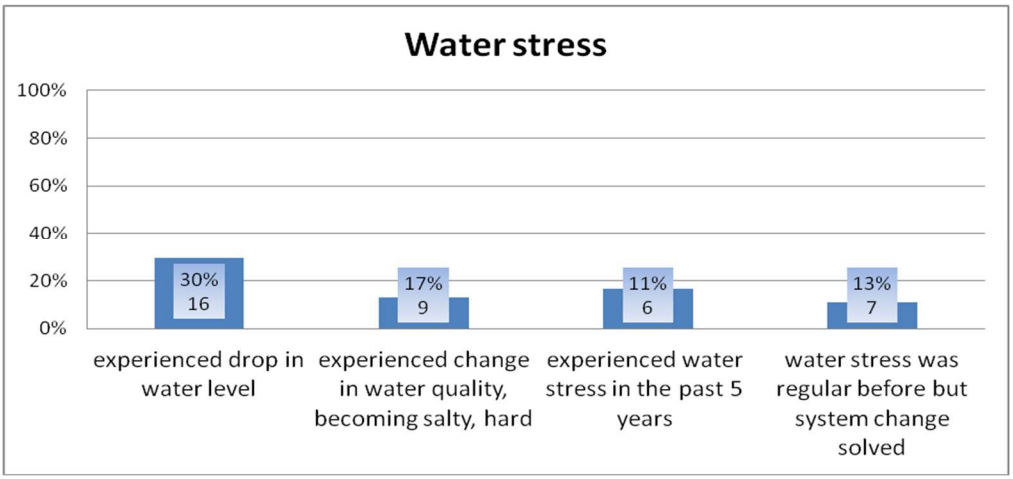


Figure 41, water stress experience on research sites

There is a seasonal fluctuation in the water level, but thirty percent of the researched communities have noticed a prominent drop in the water level throughout the past decades. In Aurolec 20 meters of water level drop was experienced in 2014. A few have experienced a change in the water quality connected to the descending water level. Due to the descending groundwater, the seawater intruded the aquifer near the coastline, and the wells became saline and thus unsuitable for human consumption or irrigation.

Water stress situations were regular in seven sites but no longer occurred since changing the supply systems' operation.

Six researched sites experienced water stress situations in the past five years. The reasons were technological breakdowns. During the time of repair, water was delivered to the sites by the Auroville Water Service.

and substantially reduce the number of people suffering from water scarcity: *Implies targeting physical and economic water scarcity to reduce its impact on people, for example, by helping those suffering from malnutrition (Normative Interpretation, UN, 2016)*

As it was described in Chapter 6.1, for short- term water stress situations, Auroville developed systems, such as backup water supply systems, mobile water tanks, and mobile water purification equipment that can be delivered to the site in need.

DISCUSSION

Target and achievements:

Normative interpretation breaks the target down into seven parts, and these are well applicable to Auroville.

Auroville is characterized by a limitation in water resources.

The largest consumer of water is agriculture, and many permaculture tools are used to reduce water consumption. The grass is not cut, and multi-layered crop production and ground cover plantation are used to achieve green water retention. No-ploughing, mulching, and micro-irrigation are applied against water loss through evaporation. Local drought-resistant plants are planted in seasonal planting. Community cuisines serve rainfed crops on their menu.

Auroville strives to reduce water consumption in industrial activities. On the one hand, they recycle water with sustainable technologies. On the other hand, they do not release toxic substances into the wastewater reused for watering. The wastewater from Colors of Nature, AV's cloth dyeing factory, is irrigated on its indigo plantation.

Households reduce water consumption with sustainable water-saving methods. Buckets are used in the showers and for dishwashing. The compost toilets are explored, and the water tanks' size is reduced in flush toilets to reduce the water use in bathrooms. Taps aerators reduce piped-water consumption.

It was impossible to determine the amount of water withdrawal. As I indicated in target 6.1, there are technical and principal reasons against water metering. Continuous observations on groundwater depth monitor the level of water scarcity.

Despite all efforts, there was a groundwater level drop. A periodic water-level change has always characterized the groundwater level, but this level has gradually and steadily declined in recent years. The water is at a critical level during periods of drought. As the water level drops, a deterioration in water quality can also be observed.

The communities have experienced reoccurring water stress situations, mainly due to technical problems. Sometimes the pipes broke down, and other times electricity was not supplied. With the diverse water supply and backup systems, the ecovillages could handle such water stress situations well. In past decades, resilience developed with an awareness of the water. Shared information warns residents of the threat, and there are times when everyone needs to reduce their water consumption.

Monitoring and indicators:

The 51 indicators are difficult to apply to ICs as the quantity of consumed water is a prerequisite for most indicators. In the literature review, I mentioned the international criticism of the UN indicator 6.4.2, the lack of green water inclusion. I found it challenging to interpret the UN indicator 6.4.1 in ICs. This indicator is helpful for production units and the business sector, measuring the economic gain on consumed water. However, this indicator does not measure the environmental pollution caused by the financial revenue and the cost of repairing the damage caused by contaminated water.

I have listed 21 additional questions in the monitoring collection.

Conclusion: The SDG6.4 target is well applicable and essential to the ICs' aims and activities. The indicators are not appropriate for ICs. New indicators are needed that focus on practices such as water use reduction methods, diversification of water supply systems, or remediation of water stress cases and strengthening community resilience.

IV.6. SDG6.5

Target 6.5: Implement Integrated Water Resources Management (IWRM) UN definition: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.

By 2030, implement: *"Refers to the Johannesburg Plan of Implementation (2002) objective to develop IWRM and water efficiency plans" (Normative Interpretation, UN, 2016)*

integrated water resources management: *"Process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems, taking into account hydrological and technical aspects, as well as socioeconomic, political and environmental dimensions" (Normative Interpretation, UN, 2016)*

In recent decades, many individuals and groups have worked on water management, and several documents, presentations, and plans were created. Sixty-two papers are listed on water topics on the https://research.auroville.org/ webpage, and many of them would fit into an IWRM concept document.

Numerous experiments and research were performed. The implementation was based on the perseverance and financial capacity of the spirited individuals behind the projects, as there was a lack of centralized governmental direction. This "anarchic" system provided an opportunity for continuous experimentation and development, and Auroville's success may lie in its creative entrepreneurship.

Integrated Water resources management focuses on supplying water for all needs. Water level has been drastically reduced in the vicinity of Auroville, due to the over-extraction of the groundwater. Alternative water sources are explored to reduce groundwater dependence.

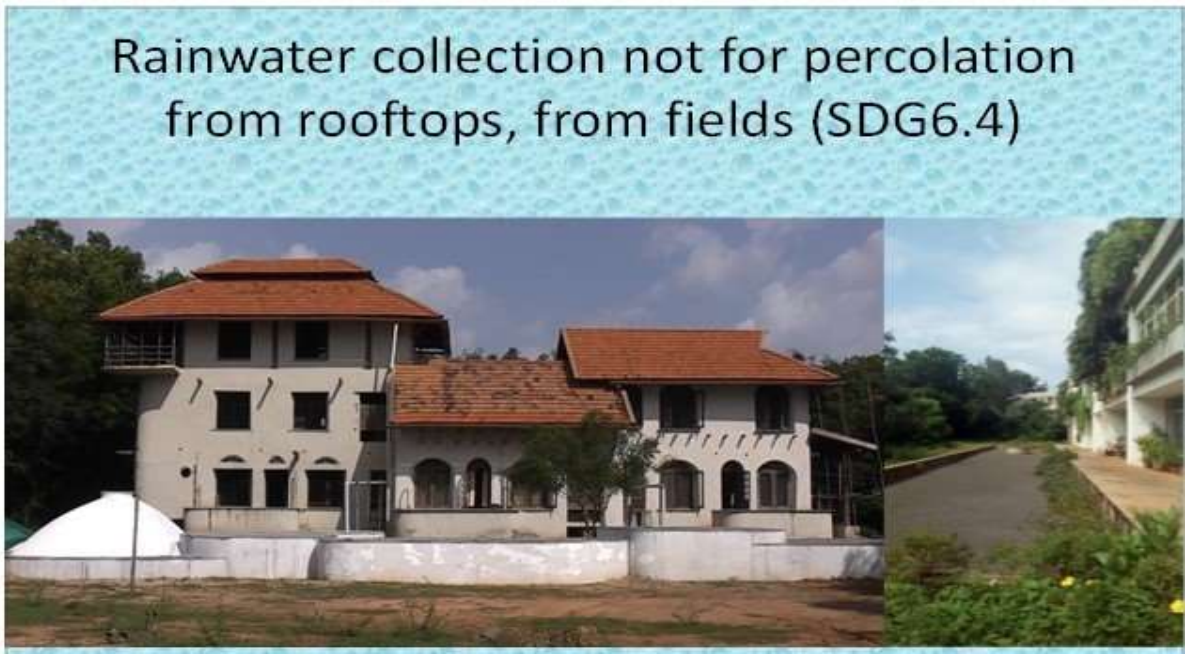


Figure 42, Rainwater collecting tanks

Rainwater is collected at some sites. Roof rainwater is collected for long-term storage and utilization in underground tanks. Some tanks are entirely covered, and no cracks and holes should be towards the surface to avoid mosquitos breeding in them. In many places, semi-open rainwater collection tanks are used, in which small fish are installed, who take care of mosquitoes. In some experiments, sloping tanks are filled with small stones or sand, and a shaft is placed at the end where water collects. The ground's downpour water is collected and stored for irrigation purposes in large non-permeable water tanks in a few forests and farms. The biggest is the 50.000 m3 capacity lakes of Annapurna farm.

Wastewater is cleaned and reused for ornamental plants' irrigation, and experiments on seawater desalination are ongoing in Quiet, and at the Varuna project.

at all levels: *"Refers primarily to vertical levels of governance, from national government to local government, basin authorities and stakeholder participation" (Normative Interpretation, UN, 2016)*

Local tropical monsoon climate is characterized by long dry periods followed by short rainy seasons. Local kings and Maharajas built rainwater collection and irrigation systems that stored water for dry periods. For thousands of years, the local Tamil people used these remarkable engineering technologies for rainwater management. In recent decades, most ancient rainwater catchment systems have perished as the system shifted to groundwater extraction. The knowledge and experience in rainwater management have now been lost. Many fast-growing cities are built on lands formerly used as rainwater catchments, causing severe problems in the event of sudden rainfall. In 2015, 300 people lost their lives in Madras, and an estimated $ 3 billion in damage was caused by an unsettled city plan.

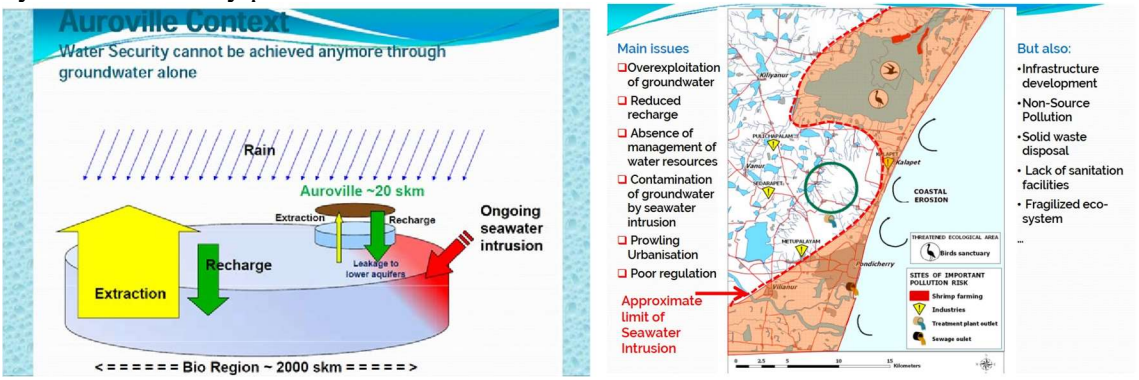


Figure 42, Groundwater over extraction

Due to the seasonal rainfall, the groundwater layers are over-extracted for agricultural cultivation, and levels have dropped drastically. Due to the lowering of the groundwater level in contrast to the rising sea level, the salinization of near-shore water resources is becoming more and more significant, and these waters are not suitable for human consumption or agricultural irrigation. In Auroville, the rate of salinization is lower than in other areas of the Coromandel Plateau, most probably due to groundwater recharge achieved through conscious landscaping work.


Figure 43 Auroville early days

Proper water management aims to achieve zero water loss, replenish groundwater resources, create water reserves, and prevent flooding. To understand the holistic and complex rainwater management system that evolved in Auroville throughout the last decades, we need to go back to the pioneering years.

Located close to the Coast of the Bay of Bengal, Auroville had to adapt to the monsoonal climate. In the pioneering years, without vegetation, the water ran off from the slightly sloppy plateau into the Bengal Bay, washing away the earth on its way and painting the sea red during the monsoon season. The stormwater dug deep canyons to find its way to the sea. The rain quickly washed away the soil layer, leaving the red eroded ground. The pioneers began to work on improving the water situation as early as the first years. Due to the unpredictability of rainwater, its abundance and scarcity caused equally challenging problems.

Figure 44 Auroville early days

At the same time when the first trees were planted, to stop losing the water and the soil, bunds were created following the contour lines and guiding the stormwater into various size soak pits and soak ponds from where it was slowly percolating into the ground.

The system's development took a lot of time and energy. When improperly constructed dams suddenly broke through, the accumulated water caused damage to young trees and homes. The dams were later reformed into stages of check dams in the canyons. The system's purpose is to divert and retain sudden rain. It hinders water away from buildings and land, slows down the water flow in the canyons, and encourages water that accumulates on the ground to seep slowly into the soil, thus replenishing groundwater resources.

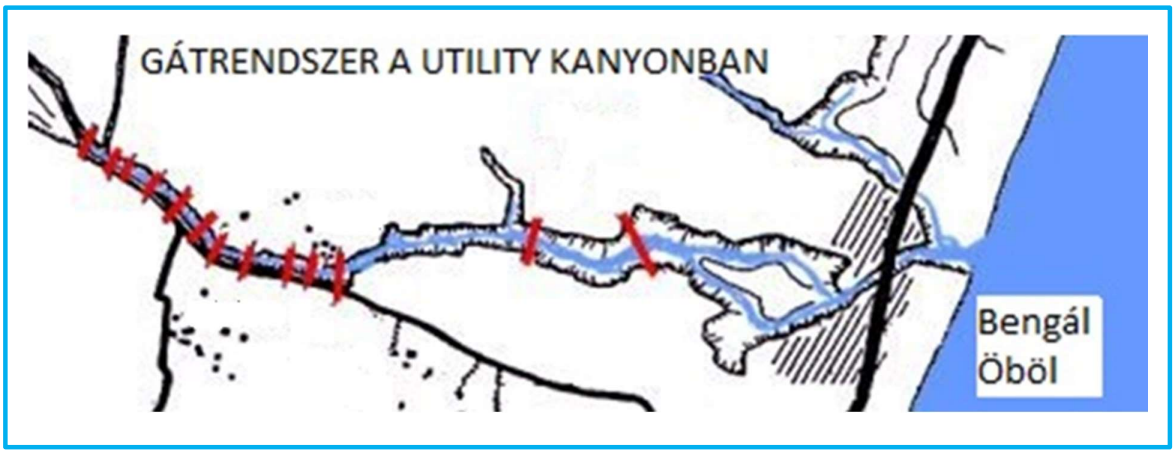


Figure 45 Check Dams in Utility Canyon

As the forest was growing, it also acted as a sponge retaining water in the soil, and an Auroville expert says zero runoff is achieved by today.

Figure 46 Check Dams and percolation ponds in Auroville

Soil and water protection and related activities were essential for successful landscaping. Whereas at first the landscaping work was done only by hand, today machines can be used for faster and more efficient landscaping.

However, Auroville is a never-ending project, and with the development of the city, which today has a population of nearly 3000 people, new challenges arise. The rainwater that is running off from roads and buildings must be managed today. All the roads and paths of Auroville are made of percolable material, and some are equipped with bunds and rainwater catchment channels, soak pits, and treelines. Vegetation of the parks and green corridors around the buildings absorb rainwater. Structures were developed to percolate the roof-water into the ground; these are used for community gatherings during dry periods.

Figure 47, Towards Zero run off in Auroville

The diagram shows that almost every researched site uses landscaping tools to engage in water retention. Most Aurovilians are involved in maintaining the bunds and forests, especially the farm and forest residents.

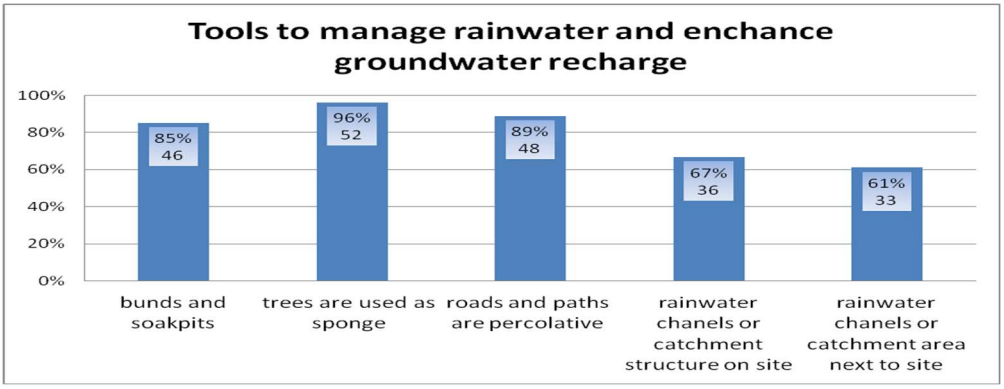


Figure 48, Rain water management

including through transboundary: *"Surface water or groundwater basins (aquifers) that cross or are located on boundaries among two or more countries; refers to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) and the Convention on the Law of the Non navigational Uses of International Watercourses (New York, 1997" (Normative Interpretation, UN, 2016)*

In Auroville, transboundary can be interpreted in several ways. Because each site has developed its ideas, rules and community values without central control, there may be two adjacent Auroville sites with conflicting interests.

However, the main challenge is that Auroville's development did not follow the original master plan. Some lands located outside the master plan are the property of Auroville, while about 70% of the land within the master plan owned by non-AV parties. This situation poses various challenges, and water-related conflicts are one.

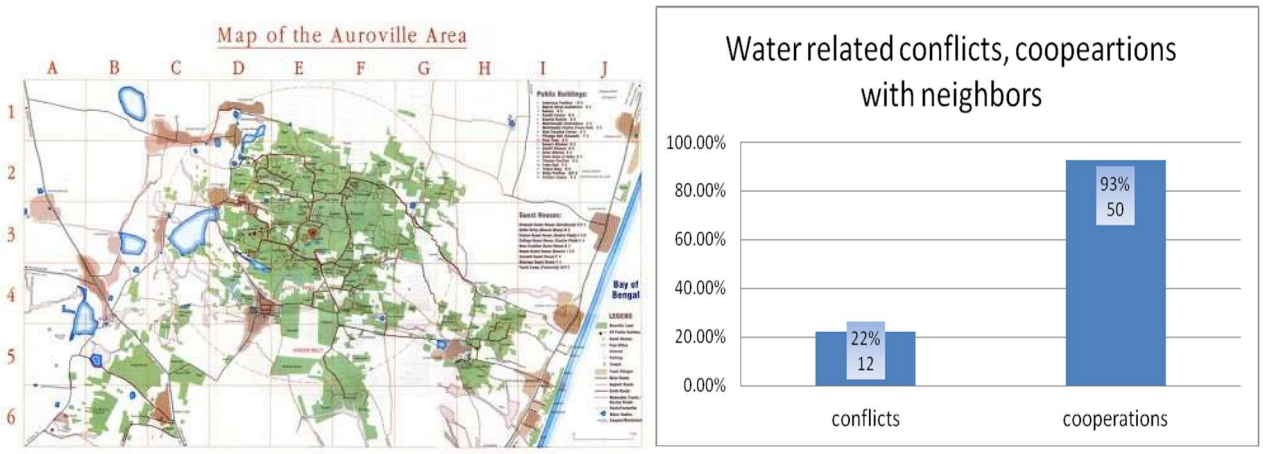


Figure 49 Auroville transboundary water issues

I have asked questions about transboundary conflict or collaboration related to Aurovillian and non-Aurovillian immediate neighbors in the research.

I have found three levels of conflict:

1) Conflicts within the site:

In some communities, conflicts arise from wastewater reuse for landscaping, as not everyone agrees it is safe and hygienic.

2) Conflicts between sites among AVians:

In some cases, during a strong monsoon, water overflows from higher-situated sites into the rainwater channel. Sometimes the unproperly constructed bunds break like in the beginning when thousands of seedlings perished, and houses were ruined. Such damage no longer occurs, but the unproperly stored wastewater may overflow in the rainwater channel during heavy rains.

One conflict reflects the different ways of thinking within Auroville. A reoccurring debate is whether the Matrimandir garden grass is sustainable or not. Some prefer a simple lifestyle and sustainability, while others embrace the community park's aesthetics and beauty.

3) Conflicts between AV sites and non-AV neighbors.

Open defecation is still widely practiced in the neighboring villages. This practice causes a reoccurring conflict on Quiet Beach.

Waste management culture is different. Garbage and sewage are dumped in the village sections of common catchment canyons, and aurovilians regularly clean it.

Some non-AV neighbors transformed the common (parambouke) water catchment land to farming. Auroville and local government officials were collaborating in restoring such rainwater catchment sites.

The biggest concern is water use. The number of groundwater wells in the close vicinity of Auroville has increased exponentially and caused groundwater level to drop.

The groundwater quality is endangered by the pesticides and agrochemicals used on neighboring farms. Industrial sites in the neighbourhood are said to inject toxic substances into groundwater.

***cooperation as appropriate**:* Customary international water law requires countries to cooperate in managing transboundary waters, with the main principles contained in the above-mentioned United Nations conventions; apart from island countries without a terrestrial border or countries not having transboundary waters, transboundary water cooperation is appropriate *(Normative Interpretation, UN, 2016)*

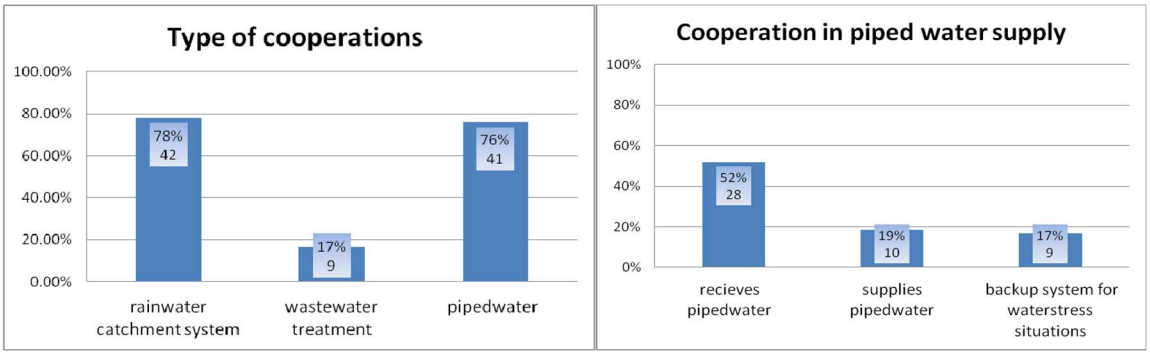


Figure 50, Water cooperation types

I found it interesting to explore the issue of transboundary conflicts and cooperation. I noticed that emerging conflicts could be the basis of cooperation. The researched sites are involved in

the three types of collaborations shown in the figure above. Today, very few sites are likely to cooperate in wastewater treatment, but this trend will change in the future.

The development of the piped water system was based on cooperation, which still exists today. The originally scattered settlements gradually filled the voids. The new sites were relying on the old ones, and together they developed the neighborhood system. This experience led to the creation of semi-centralized piped water supply systems. Of the sites examined, I found nine that are connected to more than one water supply system.

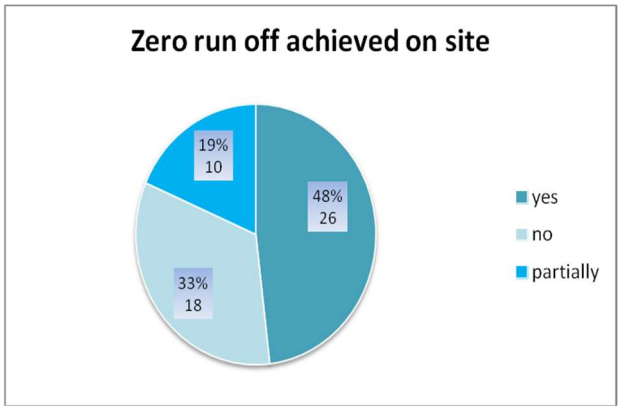


Figure 51, Zero runoff on researched sites

The most practiced cooperation efforts retain rainwater. The main driver is the rushing water itself, to which the locals try to adapt. The figure shows that 52% of researched sites are unable or only partially able to retain rainwater because they do not have adequate water retention capacity. According to some experts, zero runoff is achieved throughout the Auroville area in total. This achievement happens because certain areas are dedicated to retaining the water from the neighbors of higher plains.

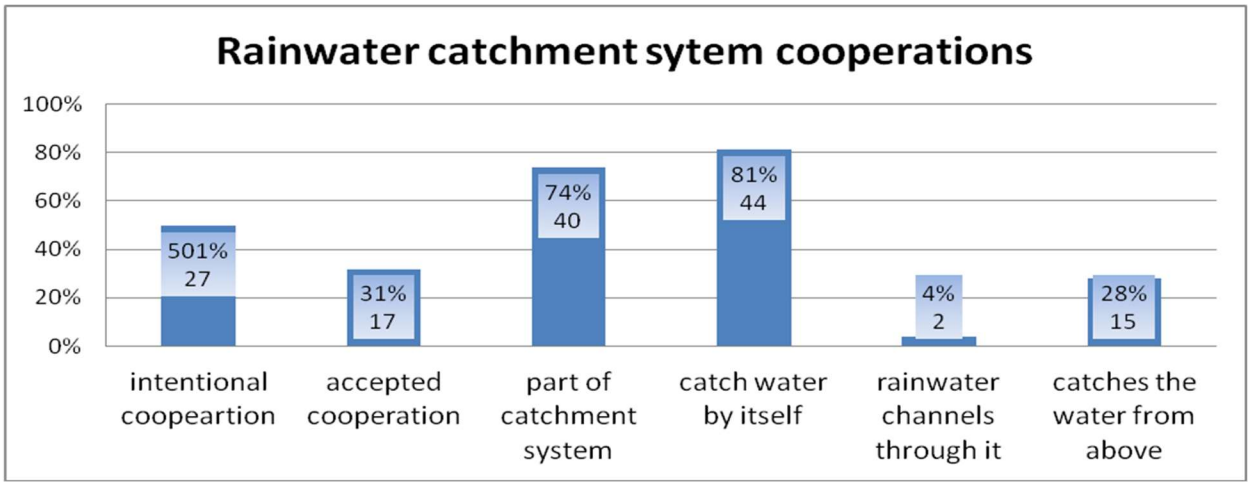


Figure 52, Rainwater catcment cooperations on researched sites

The figure below shows that 81% of researched sites have water retention landscaping tools, but only 48% can retain all site's rainwater locally. 82% of researched sites are involved in some form of cross-border collaboration on rainwater retention. On 17 sites, this cooperation is not planned but happens and is accepted. On 27 researched sites, the partnership is intentional, the cooperation is planned and communicated, and the structures are maintained and adjusted together.

With non-Av neighbors, the cooperations are concerned with the rainwater catchment and the outreach projects of the bioregion. These projects are guided by Auroville and concern hygiene, drinking water, water retention, agricultural practices, and water supply. I will describe these in more detail in chapter SDG6.A.

DISCUSSION

Target and achievement:

The normative interpretation divides this target into five parts that Auroville can interpret as its aims and activities.

Each of the studied communities depends on groundwater as the primary water source. Besides, other water resources are explored.

Wastewater is 100% reused and kept in place. I have mentioned this several times, but the action is linked with this target, too.

Efforts are made to collect rainwater, and in AV seawater desalinization experiments are underway.

Achieving green and blue water retention is emphasized at each site. Rainwater is soaked into the soil by different landscaping methods. Tillage systems were changed, trees were planted, and bunds and ditches following the contour lines were built. Dams, soak pits, and soak ponds slowly and percolate the rainwater. These methods are prominent at AV due to the monsoon weather. The used technologies keep not only the water but also the soil in place and reduce erosion.

The communities pay attention to the percolation of excess water from the built-up areas. The rainwater draining from the buildings is led into the soil with unique structures. The roads are permeable and lined with ditches, soak pits, and forest lanes.

Within Auroville, the neighborhoods are interdependent in many aspects of water management. IWRM appears primarily in the practice of collaborations for zero runoff. Collaborations are constantly evolving, just as rain patterns have changed due to climate change in recent years. Partnerships are based on personal relationships and do not typically appear in written documents or policies, but some groups and individuals are actively involved in the IWRM topic.

Because water does not stay within the human-set borders, its flow may lead to conflicts. The quantity and quality of groundwater resources were one recurring conflict theme. Contaminants from adjacent agricultural lands enter groundwater resources, and over-extraction of water for irrigation impacts the volume of the shared underground water resources.

Cooperations can develop along with conflicts. The stormwater is a coercive force and an opportunity for collaboration. There are good examples of rainwater management that deal with stormwater floods in partnership.

Monitoring and indicators:

I found 12 indicators that refer primarily to documents or regulatory systems. These are not well applicable to ICs as the collaborations are based on personal relationships and are not necessarily documented. In any case, ICs can benefit if IWRM documents reinforce the existing practices and cooperations. Among the indicators, measurements to monitor practical solutions are missing. I listed 25 additional questions in the monitoring collection.

Conclusion: The SDG6.5 target can be applied to refer to the ICs' aims and activities. The found indicators are not suitable for monitoring ICs' success. Additional indicators are needed that measure current conflicts, the amount of water retention, the achievement of zero runoff, the dependence on groundwater resources, and the use of alternative water resources.

IV.7. SDG6.6

Target 6.6: Protect and restore water-related ecosystems. UN definition: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes. The target is set to be achieved by 2020, unlike most SDG targets which have a timeline of 2030.

Most of the targets are due to be achieved by 2030, but target 6.6 is to be achieved by 2020 already.

By 2020: *Refers to the Aichi Biodiversity Targets to be reached by 2020 (Normative Interpretation, UN, 2016)*

protect: *Implies a reduction in or eradication of the loss or degradation of ecosystems (Normative Interpretation, UN, 2016)*

Auroville ave done landscape rehabilitation in a highly degraded area. Protecting the restored ecosystems is essential. Ecosystem protection is taken into account for all activities and developments. For example, trees existing on the sites are examined and taken into account when planning construction locations.

restore: *Implies a reversal of loss or degradation; assisting the recovery of degraded, damaged or destroyed ecosystems by re-establishing structural characteristics, species composition and ecological processes (Normative Interpretation, UN, 2016)*

Auroville was founded in 1968 on a barren plateau in the South of India. During British times the indigenous forest was cut, and the land became so devastated that a UNESCO survey from the 60ies identified it unfit for human habitation.

The Aurovillians started a comprehensive reforestation work. They collected seeds from the indigenous trees out of old temple gardens and sacred groves and successfully replanted the tropical dry evergreen forest with its various plants and animals. For example, in one of the researched sites, Hermitage, 500.000 trees were planted, and 26 lakes were created.

water-related ecosystems: *Whereas all ecosystems depend on water, some ecosystems – as specified below – play a more prominent role in the provision of water-related services to society (Normative Interpretation, UN, 2016)*

During the landscape rehabilitation of recent years, the former desert-like landscape has changed to a green ecosystem. The Green Belt was initially designed to provide animals and plants a living space relatively undisturbed by humans. Currently, Auroville's built up percentage is still relatively low, as shown in the table below. The data refer to the 54 research sites I examined.

Table 4: Built-up percentage in the 54% researched sites	
All area	2915774.3 m^2
Built-up area	71053.4 m^2
Built-up %	2.4

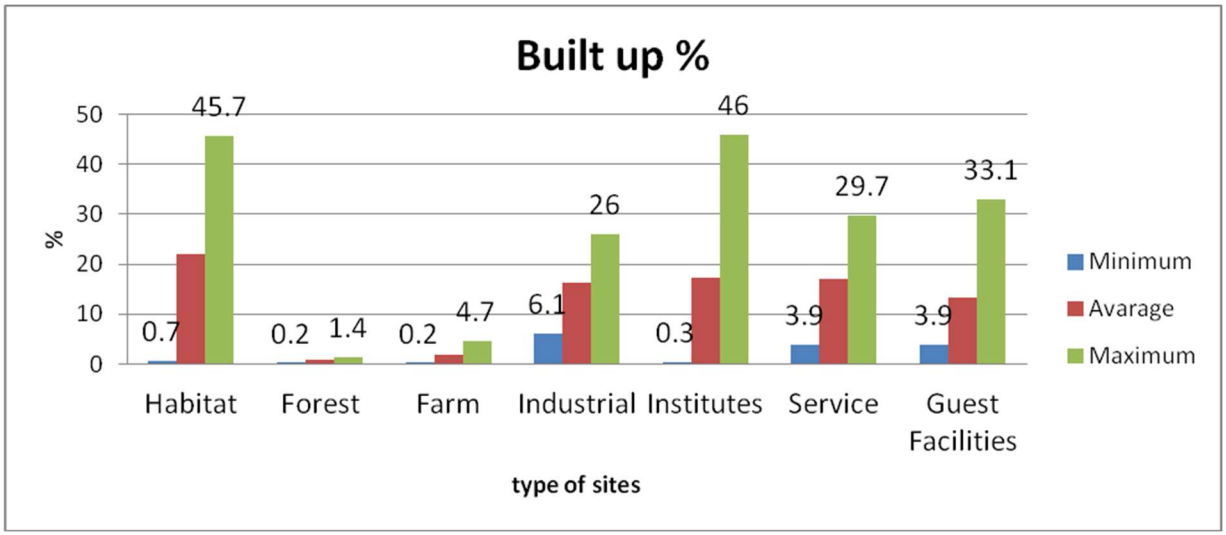


Figure 53, Built up percentage of the researched sites

As shown in the figure above, the built-up percentage is lowest on Farms and Forests located in the Green- belt. In the city area, the gardens, parks, and creeper-covered buildings host the ecosystems. Besides, water is placed out for birds for drinking and bathing

including mountains: *Most of the world's rivers are fed from mountain sources, with snow acting as a storage mechanism for downstream users; more than half of humanity depends on mountains for water (Normative Interpretation, UN, 2016)*

No mountains are located in Auroville.

Forests: *Large areas of land covered with trees or other woody vegetation, covering about 30% of the world's land area and accounting for 75% of gross primary production; forests are central for safeguarding water quantity and quality (Normative Interpretation, UN, 2016)*

Archaeological research has shown that the Auroville area has been densely populated since ancient times, but wildlife and forests were relatively undisturbed. During colonial times, forests were seen merely as opportunities for harvesting, and only the Sacred Groves were spared, where people for generations protected the trees through religious restrictions. Over the last 200 years, the native vegetation of the area, the Tropical Dry Evergreen Forest (TDEF), has been largely eradicated. The rain quickly removed the soil in the absence of ground cover, leaving behind a heavily eroded landscape. Once rich forests had become barren plateau that turned into a swamp when it rained and into a reddish desert during the dry seasons. The pioneering years of Auroville primarily focused on landscape rehabilitation through reforestation and water management. In the beginning, fast-growing trees were planted that mainly were Acacia varieties imported from Australia. Later, the focus moved to indigenous trees, and plant propagating materials were collected from temple gardens and sacred groves where strict religious restrictions have preserved the trees for centuries. The young trees required thorny fenced protection and watering for the first 3-4 years. With the return and proliferation of the indigenous animal species, the forest became self-sustaining because the

animals dispersed the seeds. Auroville's reforestation work accounts for 4% of the total area of TDEF in India (Land and Nature, 2017, auroville.org, 2017). The reforestation success in past decades has contributed substantially to the development of a pleasant microclimate and the refilling of groundwater aquifers. It has been estimated that there are approximately 5 million trees in Auroville today.

Wetlands: *Swamp, pond, peat or water, natural or artificial, permanent or temporary, stagnant or flowing water, including estuaries and marine waters down to 6 m below the low-tide mark (definition by the Ramsar Convention) (Normative Interpretation, UN, 2016)*

Rivers: *Channels where water flows continuously or periodically (Normative Interpretation, UN, 2016)*

Lakes: *Depressions in the Earth's surface occupied by bodies of standing water; they also include small and shallow water bodies, such as ponds and lagoons (Normative Interpretation, UN, 2016)*

Auroville does not have permanent natural surface water bodies. Many artificial water bodies are located in Av, like Annapurna farm reservoirs of 50000 m^3 in three tanks, or wastewater polish ponds at the Future School, Solar Kitchen, or Library. Ant channels are located around the buildings. These water tanks are full of fish and offer a superb opportunity for endangered water birds to use Auroville and its artificial ponds as their habitat.

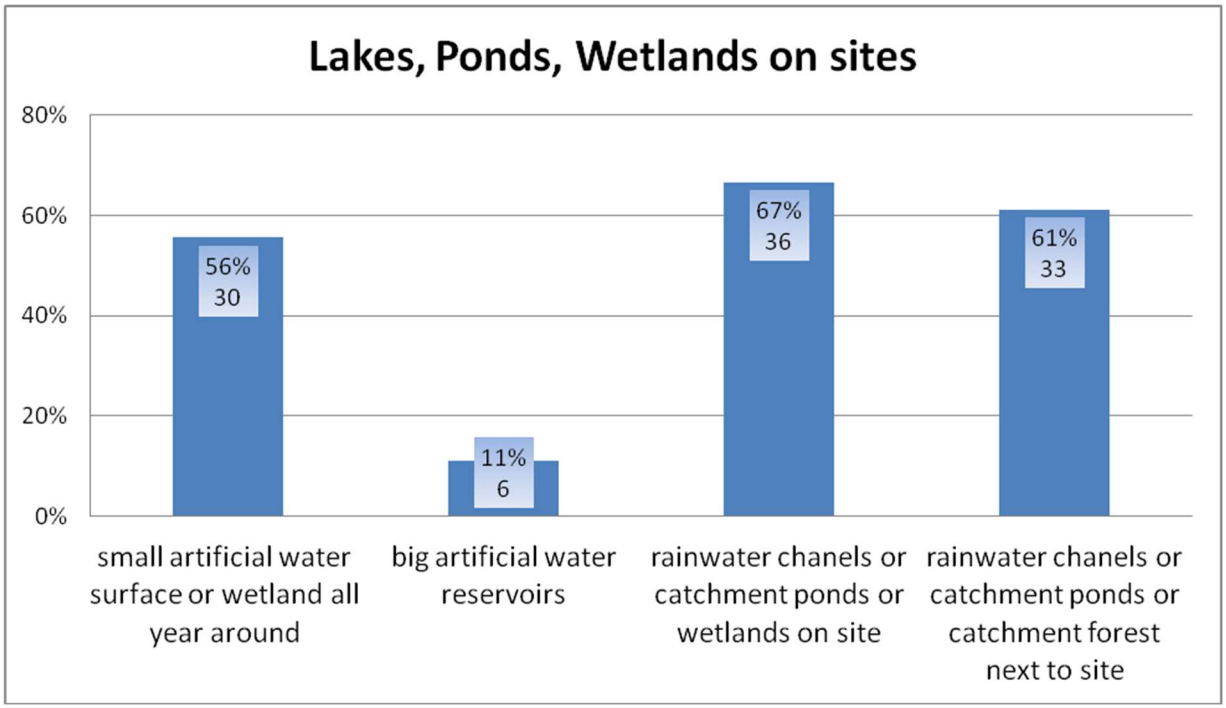


Figure 54, Water bodies on research sites

Soakpits, Soakponds, channels, and reservoirs were created to catch, guide, and reserve the monsoon's rainwater.

The polish ponds and connected wetlands are part of the wastewater treatment systems and are located in the community gardens creating a park-like environment.

Water samples were collected from 11 artificial surface water bodies in Auroville, as listed in the following table.

Table 5 Auroville Water bodies wtare quality						
	Water-body location	**pH (at 25° C)**	**EC µS/cm**	**Total Nitrogen (as N mg/l)**	**Total Phosporous (as P mg/l)**	**BOD3 mg/l**
Limit values/suggested standards						
Auroville Reservoirs						
1	Aurodam kolam	6.8	101	3.9	2.0	4.8
2	Sidharta forest kolam	6.5	79	3.3	3.0	3.9
3	Nine palms Kolam	5.9	46	1.7	1.1	1.9
4	Pitchandikulam lake	6.2	45	3.2	2.9	2.4
5	Annapoorna farm lake 1	6.8	185	4.9	3.6	3.1
6	Annapoorna farm lake 2	7.1	326	5.3	4.1	1.9
Auroville DEWATT system polish ponds						
7	Solar kitchen	6.6	440	12.9	6.6	9.9
8	Last school	6.7	90	2.9	4.9	3.1
Village reservoirs of the Auroville bioregion						
9	Allankuppam lake	6.4	77	4.7	3.8	6.6
10	Irumbai lake	6.2	85	3.7	2.3	4.1
11	Kuilapalayam lake	6.3	191	7.3	5.6	6.4

Aquifers: *Underground zones that contain sufficient saturated permeable material to yield significant quantities of water to wells and springs (Normative Interpretation, UN, 2016)*

In Auroville, we examined the groundwater quality of 10 wells from 4 different Aquifers. The Auroville Water Group GIS group provided information on aquifers.

Table 6: Aquifers water quality

	Groundwater-well location	pH (at 25° C)	EC (at 25° C) µS/cm	Nitrate (as NO3) mg/l
Limit values/suggested standards				
CUDDALORE Aquifer				
1	Revalation,	6.1	122	2.3
2	Fertile East,	6.7	492	4.7
3	Visitors centre	6.5	592	3.1
CUDDALORE-MANAVELI Aquifier				
4	Mantra	5,5	274	2,1
5	Gaia,	6,2	324	1,4
6	Center Field	5,6	157	1,7
MANAVELI Aquifier				
7	Mango Garden	7	629	9,1
8	Solitude	6,4	323	6,4
9	KK Farm	6,7	647	10,7
KADAPERIKUPPAM Aquifier				
10	Afsaneh Guest House	6,1	342	3,2

DISCUSSION

This target differs from the other SDG6 targets as it was to be achieved by 2020. It focuses on ecosystems and acknowledges the importance of water for all living beings. It underlines the common belief: “Where there is water, there is life!”

Targets and achievements:

The elements of the normative interpretation fit well in the concept of Auroville.

Auroville was launched on eroded and degraded land, and landscape restoration has been the primary goal from the beginning. First, in all locations, landscape restoration was in focus, and then the blue and green water retention capacity changed. When nature has adequate quality and quantity of water, it impacts all SDG6 targets, even SDG 6.1. Humanity is also part of nature.

The development concept includes the concentration of built-up areas, leaving room for wildlife undisturbed by human presence. The built-up zones are located in such a manner to create relatively larger continuous areas for ecosystems.

Simultaneously, it should not be forgotten that all four studied communities were to develop a human habitat. AV was a desert before its first inhabitants began planting trees. They rehabilitated the landscape near their homes for comfort, which also benefited wildlife.

Urban green infrastructure like parks around the buildings, apartment terraces with bird feeders, and green walls can function as a habitat for ecosystems. The human habitat itself can become a complex ecosystem.

In Auroville, artificial water bodies, so-called ant channels, surround the houses to prevent scorpions and ants from entering. In both Auroville and Krishna Valley, the wastewater treatment plants act as biotopes. The fishes that live in these artificial water bodies are food for waterbirds.

Soil restoration is a fundamental goal in all four ecovillages and is strongly related to water retention and biodiversity. Agriculture is organic, follows permaculture principles, and prioritizes local indigenous varieties. Agricultural lands became diverse ecosystems. Farms in Auroville are rich in biodiversity and contribute to water retention. The rainwater catchment of the Annapurna farm functions as a natural habitat.

The planted trees are protected. In some construction sites of AV first, the trees are examined by botanists. They map the trees and identify potential construction sites among the trees. Then, the architects shape and design the buildings to fit between the trees.

Economic considerations are also important. Reforestation is a significant activity in the researched ecovillages, but trees have economic value too. In Auroville, for example, the protected TDEF forest has been restored, and some trees are used for building and cooking.

Beyond the above-listed, organic agriculture in the researched communities also provides a home to valuable ecosystems. The saving of the local indigenous seeds counts for protection. The pastures are worth mentioning as important water-related ecosystems.

Several vital aspects are missing from the UN target.

One aspect missing from the 6.6 approach is that it lists ecosystems to be protected one by one, omitting the human environment. This approach does not acknowledge human habitats as a home to ecosystems. It protects habitats isolated from humans. The goal is well laid out, but it needs to include humanity as part of nature. Efforts are required to turn human settlements into diverse ecosystems in harmony with water and wildlife.

Monitoring and indicators:

I have found 58 indicators, and most can be used in ICs. The UN indicator, the waterbodies chemical quality, indicates the pollution of receiving waters and can monitor targets 6.6 and 6.3 simultaneously. It is a simple and affordable chemical test. However, I had a hard time finding limit values to evaluate the results, making it challenging to use this indicator. In any case, the chemical quality is not sufficient without information on land-use percentage.

I have added 25 indicators to the monitoring collection.

Conclusions: The SDG6.6 target and most of its indicators can be applied to refer to and monitor the ICs' aims and activities. Additional targets and indicators are needed to include human habitats and human- used lands (agriculture, forest, wastewater treatment plants, etc.) as valuable space for ecosystem restoration and protection.

IV.8. SDG6.a

Target 6.A: Expand water and sanitation support to developing countries UN definition: By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies.

In addition to the so far introduced six targets, two additional horizontal targets go beyond the technical solutions and aim to create equity by partnerships and inclusion of all human beings in the creation, maintenance and benefits of water security.

By 2030, expand international cooperation: *Implies aid in the form of grants or loans from external support agencies (Normative Interpretation, UN, 2016)*

Auroville not only experiments and finds solutions for its local challenges but also shares its knowledge with the world. In past decades, Auroville participated in projects to solve water-related challenges in the close vicinity of Auroville and all over India and the world.

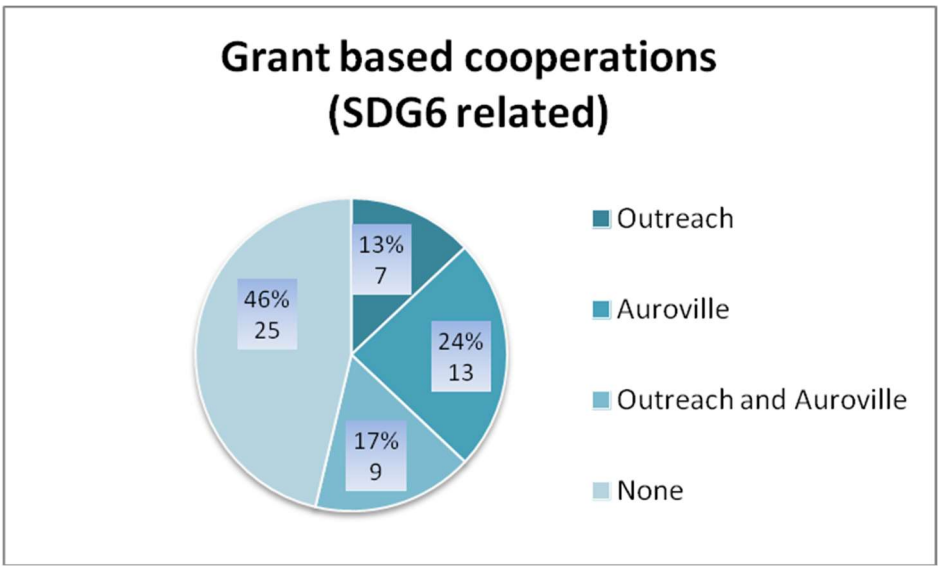


Figure 55, Existing cooperations on researched sites

The above diagram shows the type of water-related grant collaborations in where the researched sites participated.

and capacitybuilding support: *Implies strengthening the skills, competencies and abilities of people and communities, so that they can overcome the causes of their exclusion and suffering (Normative Interpretation, UN, 2016)*

Auroville offers on-site learning opportunities and can be seen as a center for knowledge sharing or a practical university. Approximately 1 million people visit it every year, including student groups from universities, and NGOs, village representatives, and curious individuals who come to Auroville to learn these practical solutions on site.

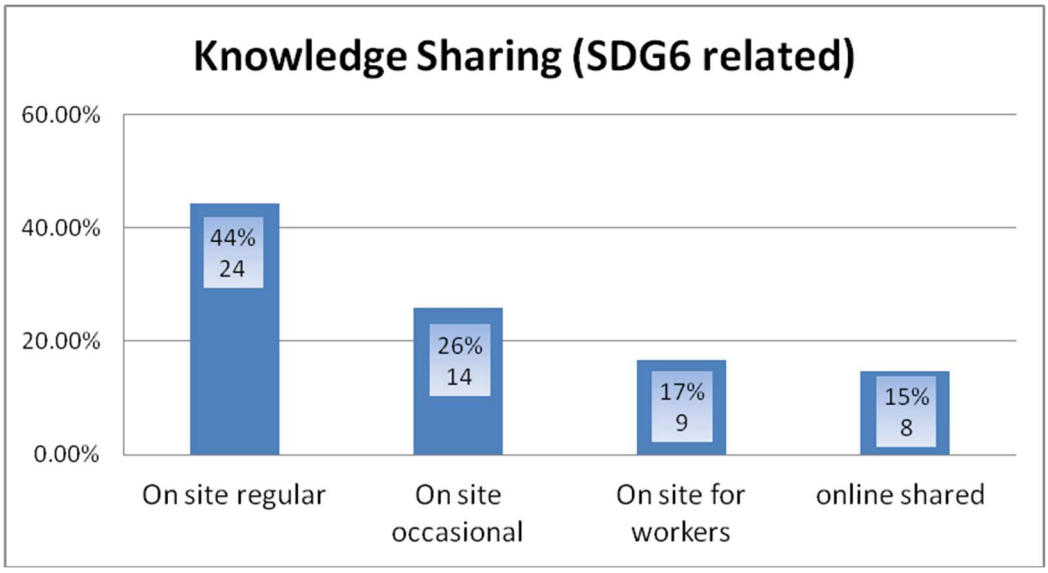


Figure 56, Existing educational activities on the researched sites

The above figure shows that most sites (70%) welcome learning visitors.

in water- and sanitation-related activities and programmes, including water harvesting, desa lination, water efficiency, wastewater treatment, recycling and reuse technologies: *Practices, processes and technologies that support progress towards water- and sanitation-related targets; the monitoring of water and sanitation, including observation networks and databases for surface and groundwater, is also important (Normative Interpretation, UN, 2016)*

Below I am listing a few of the funded projects where Auroville actively participated with its expertise, and Auroville units were the projects' driving force.

6.1: Drinking water

Sunlit Future Auroville: participation in the Grundfos Foundation 100 pumps, 100 villages project for 50,000 people.

http://www.sunlitfuture.in/gallery/

6.2: Sanitation and hygiene, 6.3 Water quality and wastewater

Ecofemme gave free training on menstrual health education to over 44,000 girls and has sold and/or freely distributed a total of 7,31,264 cloth pads, saving 54.8 million disposable pads from landfills.

6.4 Water use and Scarcity

Auroville Consulting in Collaboration with Innovative UK, German International Cooperation, Heriot-Watt University, and NABARD implemented Smart Agricultural Irrigation Control systems in 20 farms in Karnataka, Maharashtra, and Tamil Nadu.

6.5: Water management

In Collaboration with the Ministry of Rural Development of India and the Indian Canadian Environmental Facility, Palmyra restored 29 water tanks and 12,06 km of water channels, planted 83.000 trees, and built check dams to stop soil erosion and water loss.

Channel in Allankuppam village – Before Rehabilitation	Channel /Checkdam in Allankuppam village – After Rehabilitation

Figure 57, Rehabilitation projects in the Auroville neighborhood

6.6: Ecosystems

Pitchandikulam Forest Consultants collaborated in the restoration of more than 700 acres of land with lakes and forests.

For more info visit: *http://www.pitchandikulamforest.org/PF/nadukuppam-forest/*

DISCUSSION

Target and achievements:

The normative interpretation is relatively short and divides the target into three parts that fit well with the goals and activities of Auroville.

A characteristic is the willingness to participate in knowledge sharing. Auroville collaborates with educational institutions, local governments, and individual stakeholders and offers practical on-site learning. Auroville is called by many a University referring to one of its slogans: “UNIty in diVERSITY”.

Another characteristic lies in its members’ eagerness to learn and evolve.

Auroville participates as a regular partner in water-related assistance programs. I want to highlight that the listed assistance projects are not managed by Auroville but by individuals living in Auroville. These are strong, determined, and enthusiastic experts who take advantage of AV’s international environment for national and international collaborations. Auroville’s long-term reputation is the guarantee. In the listed assistance programs, aurovilians are either the guiding force of the project or invited experts who contribute to an existing project with their professional knowledge.

Monitoring and indicators:

I have found only four indicators that provide data on water development assistance and knowledge-sharing collaboration programs. I have added seven questions to the monitoring collection.

Conclusion: The SDG6.a target and its indicators can be applied to refer to and monitor the ICs aims and activities. Additional indicators are needed to monitor online shared practical information, the capacity or experience for on-site learning, and the involvement in assistance or knowledge transfer programs.

IV.9. SDG6.b

Target 6.B: UN definition: Support and strengthen the participation of local communities in improving water and sanitation management.

Support and strengthen the participation: *Participation implies a mechanism by which individuals and communities can meaningfully contribute to decisions and directions on water and sanitation planning that affect or can be affected by them (Normative Interpretation, UN, 2016)*

No matter how sophisticated methods and technological solutions are available, the SDG6 targets cannot be achieved without people's involvement and participation. Aurovilians are actively engaged in achieving water security and water autonomy. There are regular discussions, meetings, and presentations on water topics, and water is a recurring theme in the local radio, newspapers, and social media platforms. Water is integrated into the decision-making processes of planning, development, and management of Auroville.

Regarding administration, on most of the researched sites, an institute or income generator unit covers the occurring maintenance costs of the water supply systems.

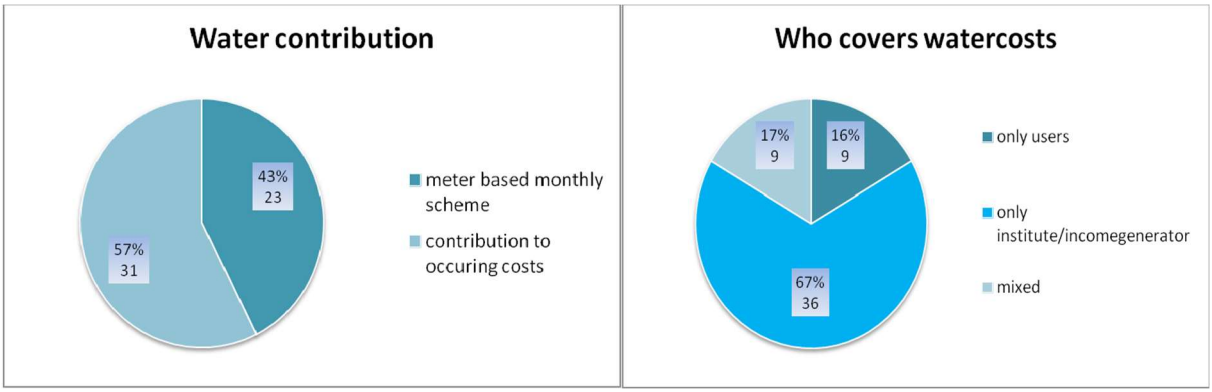


Figure 58, Water costs sharing in the researched Auroville sites

local communities: *Groups of interacting people living in a common location (Normative Interpretation, UN, 2016)*

AV: All over India, water used to be sacred, and connected rituals are practised still today. Water's sacredness is represented in Auroville in many ways; I mention just two of these here.

Auroville hosts the Aquatic Bodywork Centre of India. In its warm water pool, trainings and sessions are offered to visitors from all around the world, sharing the healing powers of water. As we can see in the table, these programs are popular among aurovilians as well.

Table 7: Aquatic Bodywork Courses & Watsu Treatments 2007- 2019														
	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19	TOT.	%
COURSES														
Number of Courses	**13**	**15**	**15**	**14**	**20**	**12**	**14**	**16**	**23**	**26**	**23**	**22**	**213**	
Number of Guests	62	58	86	79	85	64	103	99	157	162	166	126	**1247**	**65%**
Number of Avns	87	86	83	83	83	35	26	33	32	49	33	45	**675**	**35%**
TOTAL	**149**	**144**	**169**	**162**	**168**	**99**	**129**	**132**	**189**	**211**	**199**	**171**	**1922**	**100%**
TREATMENTS														
Number of Guests	718	721	595	730	663	901	766	766	709	867	747	942	**9125**	**75%**
Number of Avns	285	307	271	303	301	240	220	196	134	304	145	278	**2984**	**25%**
TOTAL	**1003**	**1028**	**866**	**1033**	**964**	**1141**	**986**	**962**	**843**	**1171**	**892**	**1220**	**12109**	**100%**

On the 50th Birthday of Auroville, a special ceremony was held to celebrate and honour the water. Water from over 400 sources of the world was mixed into a golden bowl, representing unity and oneness and expressing Auroville's wish to co-create a water-secure future.

For more info please visit: https://auroville.org/contents/4257

in improving water and sanitation management: *Implies improving the management of all aspects of water and sanitation (Normative Interpretation, UN, 2016)*

The deep gratitude and honour that Auroville treats water is the creative inspiration behind past decades of pioneering experiments and practical solutions. Aurovilians have convenient options and choices to contribute to SDG6. Biodegradable cleaning products are available in the local shops, rain-fed crops are served at the local restaurants, and indigenous water-resistant plants are available in the local seed banks. Community activities like collecting plastic garbage from the nearby villages' water channels, or reconstructing the Auroville bunds and planting trees in the monsoon season empower the people to co-create a water-secure community.

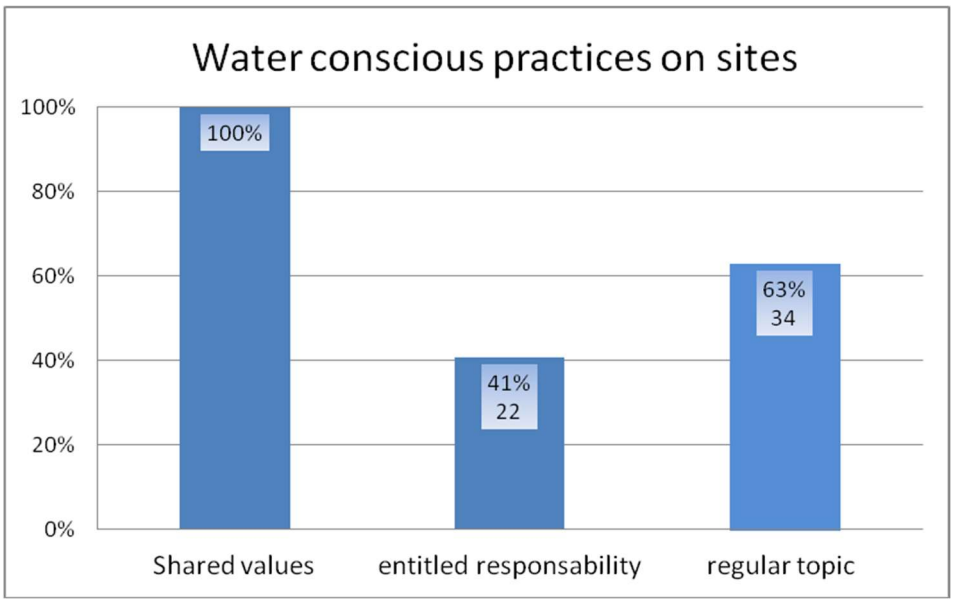


Figure 59, Water conscious practices on researched Auroville sites

When I asked what provided water security within the community, shared values, and responsibility were mentioned as the primary cause. In some sites, water-related responsibilities are in addition entitled to one person, but there is a general trust in the site members' awareness and practices.

DISCUSSION

In AV, I had the opportunity to attend a lecture by Dr Rajendra Singh. Dr Rajendra Singh is an Indian water conservationist and environmentalist from Rajasthan in India. Also known as "waterman of India", he won the Stockholm Water Prize in 2015. His experience in local water management shows that technological solutions are partial, and success depends on the attitudes of local communities. Even the best technical solution will fail if we cannot put society on its side. Simultaneously, a well-functioning local community can establish and maintain resilient water management even with limited financial and technological resources. Responsible and conscious community members can restore and conserve local water quality and quantity. In India, for thousands of years, strong habits, taboos, and cultural norms were the driving force behind successful rainwater management. These cultural values have been lost, and today service providers control the water's quality and quantity.

Target and achievements:

The normative interpretation is relatively short and divides the target into three parts that fit well with the goals and activities of Auroville.

The local communities are actively involved in water-related decisions. The community engagement is accompanied by technological solutions adapted to the residents.

At the local store, biodegradable, environmentally friendly cleaning products are sold without packaging. Drought-resistant plants can be planted in the gardens, for which both technological know-how and seeds are available in Auroville. Individual households play an active role in water retention, rainwater management, and the reduction of wastewater pollution. The public

drinking fountains offer purified drinking water for all.

The community organization helps individuals with water-conscious choices that are readily available. Public venues use environmentally friendly cleaning products, and awareness campaigns educate residents. Community resources are used to experiment with new technologies in community schools and institutions. Committed individuals fund and execute new experiments. The successful tools and methods then spread throughout the community, not under coercion from above but based on individual certitude and responsibility.

Auroville provides easily accessible means for individuals for sustainable lives but leaves them free choice. If the recommended method is not suitable for any member, they are not forced to use it. For example, if someone does not want to use a compost toilet or does not trust biodegradable cleaning products, they can use different products. On the other hand, the residents can explore and learn water-conscious solutions in the community. Some women are given free menstrual cloth pads in AV, but it's their free choice to use them.

Individuals and the community act to pursue sustainable water management together. Individual freedom is fundamental, but there is strong trust that everyone will protect the water. Locals rely on each other and feel confident in interdependent situations. Although authorized persons are responsible for checking the leaking pipes and dripping taps, every member of the community, even the smallest ones, pays attention to these tasks. The system relies and counts on the awareness and responsibility of its members.

The significance of this target is to empower local communities to engage in local water management. The members trust each other, that everyone pays attention to the water, not polluting it and not wasting it. The ICs systems strengthen the community feeling itself by its dependence on its residents.

There is an additional cultural-spiritual aspect. In AV, water is seen as a healing medium in the aquatic bodywork center. Water-related spiritual attitudes also appeared in the two juvenile communities.

Monitoring and indicators:

The 31 found indicators include 20 indicators from New York VLR, which examine customer satisfaction and service reliability. Interestingly, out of NY's 29 SDG 6 indicators, 20 are aligned to the 6. b target, which could be an example of the importance of SDG 6 for all municipalities.

The remaining 11 indicators refer to documents, laws, policies, and planning processes in which local communities can participate.

Only a few indicators can be suitable for measuring ICs. I added 18 additional questions to the monitoring list. A simple hand could measure the water management topics that appear in the local media, the community's engagement in the communication, and the available online or printed publications that provide information to the residents. Targets and indicators could also represent the socio-spiritual approach.

Conclusion: The SDG6.b target is well applicable to ICs aims and activities. The found indicators are only partially suitable for monitoring ICs. Additional indicators are needed to measure the number of social sensitization programs and the extent of shared information and responsibility for water.

V. CONCLUSIONS

Decades of work at the UN have developed the SDGs, which articulate our current reality's global and local problems. The UN principle, "leaving no-one behind", is included in the internal values of the ICs I have studied. However, the attitude of ICs differs from UN. The UN puts more energy into planning SDGs, while ICs prefer prototyping and are seen as living laboratories. They are characterized by experiments and are open to learning from failures, just like the kindergarten students in the marshmallow challenge.

Tom Wujec's marshmallow experiment drew attention to the importance of prototyping and learning from failure. Small teams have to build a structure in a limited time using sticks of spaghetti, tape, string, and one marshmallow. The winning team is the one that can construct the tallest freestanding structure with the marshmallow on top within the time allowed. In his experiment, Wujec found that kindergarten students were more successful than business school graduates or CEOs. The reason was that the kids spent less time planning and discussing but started prototyping early on and then redefining their model based on their failures. The marshmallow challenge underlines that we need trials and failures from which we can learn.

One of the reasons for the spirit of experimentation in ICs lies in the community members themselves. People join ICs who carry a sense of dissatisfaction with the current world and want to create something new. Many experiments failed in the last decades, but those that succeeded have persisted and are widespread in the community as both technically and socially sustainable solutions. If we want to achieve the SDGs, it is necessary to use the practical experience accumulated in the ICs. The ICs are the living laboratories that can offer valuable good practices for SDG achievement in their regions.

Table 8 illustrates that based on my research on Auroville and other intentional communities, the UN SDGs are already embedded in Auroville's work, even preceding the formalization of these goals. This alignment shows that the direction is sound and that the SDGs are applicable to Auroville as well. However, monitoring tools specific to Auroville and other intentional communities should be further developed.

In this study, I analyzed each SDG6 target, including sub-targets as defined by normative interpretations. Where possible, I used quantitative indicators; where not feasible, I gathered data through qualitative interviews. The qualitative data was quantified by covering a large number of sites.

Detailed findings are included in the published study, and a summary of key points follows:

SDG 6.1: The normative interpretation divides this target into eight parts, each aligning well with Auroville's functioning and objectives. The community has a reliable piped water supply, primarily sourced from groundwater, with measures to maintain quality and prevent contaminants. Organic agriculture minimizes chemical threats, pipes are regularly inspected and replaced, and modern science and lab testing guide hygienic practices. Water diversification strategies ensure supply, and drinking water is purified with reverse osmosis, offered through public fountains, with reduced use of plastic bottled water. Water metering and pricing are currently absent due to technical and philosophical reasons.

SDG 6.2: This target, divided into eight parts, aligns well with Auroville's sanitation and hygiene efforts. Local systems manage excreta safely, and composting toilets are available as an eco-friendly option. Public toilets are safe and accessible, with provisions for women's menstrual hygiene supported by EcoFemme, a social enterprise promoting eco-friendly menstrual products. Handwashing stations with biodegradable soap are common, and hygiene protocols are monitored rigorously due to shared dining and food production facilities.

SDG 6.3: Wastewater is prevented from entering natural water bodies and is seen as a valuable resource, often reused for irrigation. Organic practices reduce toxins in wastewater, which is carefully separated and managed. Auroville has also implemented ornamental ponds that add aesthetic and biodiversity value. Waste reduction efforts include composting, selective garbage collection, and promoting packaging-free goods.

SDG 6.4: Auroville's water resources are limited, especially in agriculture. Permaculture techniques like no-ploughing, mulching, and drought-resistant crops reduce water use, while water-saving practices are common in households. Monitoring groundwater depth provides insight into water scarcity, and though resilient, the community has experienced water stress, handled through diverse supply and backup systems.

SDG 6.5: With five parts, this target focuses on integrated water resource management (IWRM). Groundwater is the primary source, and rainwater harvesting and seawater desalination are being explored. Collaborative efforts for stormwater management fostered resilience. Although informal, these collaborations underscore interdependence and adaptability in managing shared water resources.

SDG 6.6: Since its inception, Auroville has focused on land restoration and creating a biodiverse ecosystem, balancing human and natural habitats. Reforestation, organic agriculture, and habitat-sensitive construction methods foster local ecosystems. Protected forests are carefully managed, and economic considerations are factored into sustainable practices. Auroville's ecosystem-oriented approach integrates human habitats as part of nature, an aspect missing in the UN target's current framework.

SDG 6.a: Auroville's commitment to knowledge-sharing and international collaboration exemplifies this target. Individuals and experts from Auroville engage in water-related assistance programs, benefiting from its international environment. Auroville's ethos as a "University" fosters a culture of lifelong learning and collaborative growth.

SDG 6.b: Auroville empowers local communities in water management, offering biodegradable products and water-conscious gardening options. Community members freely choose sustainable practices, relying on trust and mutual responsibility. This system, rooted in both practical and cultural-spiritual views, nurtures community cohesion and interdependence.

In conclusion, the best practices from Auroville are worth disseminating broadly.

Table 8: Analysis of SDG6 targets and indicators applicability in Ecovillages -ICs								
	SDG6.1	SDG6.2	SDG6.3	SDG6.4	SDG6.5	SDG6.6	SDG6.A	SDG6.B
Normative Interpretation	8	8	8	7	5	?	3	3
Applicability	Well	well	Well	Well	Well	well	Well	Well
Indicators	28	26	48	51	12	58	4	31
Applicability	Well	well	Well	Negligible	Negligible	well	Moderately	negligible
Added questions	40	45	31	21	25	25	7	18
Suggestions	The SDG 6.1 target and most of its indicators are suitable to refer to and monitor the ICs aims and activities. Additional targets and indicators are needed to monitor the quality and quantity of directly consumed drinking water and address plastic bottled water consumption	The SDG6.2 target and most of its indicators can be applied to refer to and monitor the ICs aims and activities. Additional targets and indicators are needed to include the application of compost toilets and the management of non-degradable sanitation waste. The sanitation practices category need enlargement, including the co-housing type shared toilet-bathrooms as non-limited	The SDG 6.3 target and most of its indicators can be applied to refer to and monitor the ICs aims and activities. Additional targets and indicators are needed to include biodegradable detergents, greywater separation, consumer habits and wastewater retention.	The SDG6.4 target is well applicable and essential to the ICs aims and activities. The indicators are not appropriate for ICs. New indicators are needed that focus on practices such as water use reduction methods, diversification of water supply systems, or remediation of water stress cases and strengthening community resilience	The SDG6.5 target can be applied to refer to the ICs aims and activities. The found indicators are not suitable to monitor ICs success. Additional indicators are needed that measure current conflicts, the amount of water retention, the achievement of zero runoff, the dependence on groundwater resources and the use of alternative water resources	The SDG6.6 target and most of its indicators can be applied to refer to and monitor the ICs aims and activities. Additional targets and indicators are needed to include the human habitats and human used lands (agriculture, forest, wastewater treatment plants, etc.) as valuable space for ecosystem restoration and protection.	The SDG6.a target and its indicators can be applied to refer to and monitor the ICs aims and activities. Additional indicators are needed to monitor online shared practical information, the capacity or experience for on-site learning and the involvement in assistance or knowledge transfer programs	The SDG6.b target is well applicable to ICs aims and activities. The found indicators are only partially suitable for monitoring ICs. Additional indicators are needed to measure the number of social sensitization programs and the extent of shared information and responsibility on water.

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VII. ANNEX

Interviewed Auroville experst and stakeholders						
Central/overall management and administration	Waste-wastewater management	Food and Farming	Forest/landscape restoration	Hygiene-Laboratory drinking water safety	Alternative architecture	Public engagement: Auroville, bioregion and beyond
Luca	Hervé	Priya,	Paul	Satyavidi	Manu	Mita
Gilles	Jesus	Krishna	Josh	Alok	Dharmesh	Guido
Toby	Jan	Angelika	Patrick	Igor	Eugen	Juergen P
Slava	Jean Francis	Thomas	Bern	Lucas	Michael	Kavit
Ole	Jhonny	Hendrik	Kireet	Jessaminj	Rene	AVAG
Sauro	Palani	Akash		Paula	David	Ram
Andrea	Lucas	Martina				Ing-Marie
Harini	Hari	Jasmin				Martin
Vinnay		Christian				Michael S
Palani A		Charlie				Giulio

Researched Auroville Habitats						
HABITATS	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Location on Masterplan
Citadines	56	56	10845.58	1225.69	11.3	Administrative
Courage	110	110	12504.79	2235.5	17.9	Residential
Djaima	35	35	72681.54	2917.39	4	outer
Human Scapes	34	34	9550.581	1978.28	20.7	Residential
Kriya	50	50	11290.73	1400	12.4	Residential
Mahalakshmi Assisted Living	20	25	205863.6	1372.23	0.7	Cultural
New Creation	80	180	30877.51	4499.28	14.6	outer
Sacred Groves	30	125	23148.02	816.2	35.3	Residential
Samasti	50	50	28408.93	2367.96	8.3	Green Belt

Sunship	70	70	3035.142	1388	45.7	Administrative
Swayam	50	75	8296.056	1218	14.7	Residential
avarage	53.2	73.6	37863.9	1947.1	16.9	
minimum	20	25	3035.142	816.2	0.7	
maximum	110	180	205863.6	4499.3	45.7	

Researched Auroville Forests						
FORESTS	Minimum people	Maximum people	Site size m2	Built-up area m^2	Built-up %	Zone
Botanical Garden	30	70	202909.4	1366	0.7	Green Belt
Hermitage	9	9	253859.3	504	0.2	outer
Nilattangam	2	14	35005.31	476	1.4	Green Belt
Pitchandikulam Forest	25	45	262155.4	2113.39	0.8	Green Belt
Revelation	12	20	274336.4	934	0.3	Green Belt
Sidharta Forest	10	20	37878.58	414	1.1	Green Belt
avarage	14.7	29.7	177690.7	967.9	0.8	
minimum	2	9	35005.3	414	0.2	
maximum	30	70	274336	2113.4	1.4	

Researched Auroville Farms						
FARMS	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Master-Plan Zone
Annapurna Farm	20	50	662268.1	1218	0.2	outer
AuroGreen	12	12	122822.1	1536	1.3	Green Belt

Ayyarpadi	15	15	94575.03	445	4.7	International
Red Earth Riding School	14	40	47793.37	722	1.5	Outer
Windarra-TerraSoul	13	23	79561.2	1232	1.5	Green-Belt
avarage	14.8	28.0	201404	1030.6	1.8	
minimum	12	12	47793.4	445	0.2	
maximum	20	50	662268	1536	4.7	

Researched Auroville Industrial Complexes						
Industrial complexes	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Zone
AquaDyn	21	21	7405.7	1922	26	outer
Aureka	45	45	6879.7	1096	15.9	outer
Colors of Nature	80	80	15216	922	6.1	industrial
Eco-Femme-Sara-con	80	100	1821.1	458	25.1	industrial
Naturelmant	55	90	10239	1190	11.6	industrial
Svaram	45	120	4208.7	812	19.3	industrial
Sunlit Future	40	40	8336.5	786	9.4	industrial
avarage	52.3	70.9	7729.5	1026.6	16.2	
minimum	21	21	1821.1	458	6.1	
maximum	80	120	15216	1922	26	

Researched Auroville Institutes						
Institutes/ Cultural centers	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Zone
Aikiyam School	100	270	6839.187	1632	23.9	outer
Deepam School	45	45	15297.12	1625.6	10.6	outer
Language Lab	10	80	2711.394	1249	46	international
Last School	50	50	6223	1307	21	cultural
Library	30	80	4249.199	804	18.9	residential
Nandanam School	80	100	9671.987	1209	12.5	residential
Pitanga	25	300	8862.616	668	7.5	residential
Unity Pavilion	15	200	7284.342	1035	14.2	international
Youth Center/Manolo	6	500	53378.04	177	0.3	Green Belt
avarage	40.1	180.6	12724.1	1078.5	17.2	
minimum	6	45	2711.394	177	0.3	
maximum	100	500	53378.04	1632	46	

Researched Auroville Service Complexes						
Service Complex	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Zone
Aurolec	100	100	21044	825	3.9	outer
Auroville Health Center	50	100	3925.5	815	20.8	outer
Pour Tous	250	350	4249.2	1036.7	24.4	outer
SAIIER building	30	150	2266.2	672	29.7	administrative
Santé	25	100	2428.1	498	20.5	residential

SLI	30	100	4120	300	7.3	outer
Solar Kitchen	500	600	24362	3115.5	12.8	residential
Town Hall	200	450	3116.1	520	16.7	administrative
Transport Service	13	13	6570	712		Green Belt
avarage	133.1	218.1	8009.0	943.8	17.0	
minimum	13	13	2266.2	300	3.9	
maximum	500	600	24362	3115.5	29.7	

Researched Auroville Guest Facilities

Guest facilities	Minimum people	Maximum people	Site size m^2	Built-up area m^2	Built-up %	Zone
Arka	30	60	12707.13	1707	13.4	Residential
International house	15	50	11398	950.25	8.3	International
Mitra	47	47	1618.743	535	33.1	Administrative
Quiet Healing Center	21	120	26326	2907	11.0	Outer
Tibetan Pavilion	6	30	7415.46	1283.5	17.3	International
Verite	30	100	37676.23	2431	6.4	Industrial
Visitors center	1000	8000	88261.94	3474	3.9	International
avarage	*164.1*	*1201.0*	26486.2	1898.2	13.4	
minimum	*6*	*30*	1618.743	535	3.9	
maximum	*1000*	*8000*	88261.94	3474	33.1	

GENERAL CASESTUDY DATASHEET FOR SDG6 DATA COLLECTION ON THE RESEARCHED SITES

Name of the community, settlement,
Name of the interviewed, age, origin, connection to the community, since when…
Type of site , Focus of work, Activities on site
Daily nr of people on site, Nr of people (workers, habitants), Nr of visitors per day average Minimum, Maximum, Average
Size of the site **A**
Size of built up/tar covered area (no percolation like buildings, tar-roads, statues etc) **B**
Land use percentage(park, forest, garden, built up area, etc) **B/A*100**
Water origin by source
Water usage year/month/day
Water quality
Water storage

SDG6.1: "*By 2030, achieve universal and equitable access to safe and affordable drinking water for all".*

Table 1, Indicators and Questions to "UNIVERSAL"	
Normative Interpretation: Implies all exposures and settings including households, schools, health-care facilities and workplaces	
Indicators	
NIF2018, INindex2018	Percentage of population having safe and adequate drinking water within their premises.
UN	Proportion of population using safely managed drinking water services
UNSTAT	Proportion of population using safely managed drinking water services, by urban/rural
Basque	Total water supply
Toyoma	Water service coverage
Shimokawa	Percentage of water coverage by population
Shimokawa	Water supplied per residents
New York	Average daily in-City water consumption (millions of gallons) Description: The mean number of gallons delivered each day for in-City consumption.
Questions	
What is the source of water for drinking, cooking and personal hygiene in the community?	If water is carried in a private refillable container, than, it's not packaged water and please mark here the source of the carried water.
Where is the drinking water source located? On premises?	

Table 2, Indicators and Questions to "EQUITABLE"	
Normative interpretation: Implies progressive reduction and elimination of inequalities among population subgroups	
Indicators	
Business	Percentage of rights holders report that they have not experienced threats/assaults
Business	Percentage of rights holders with access to information about water related issues
New York	Overall enforcement activity
Questions	
What type of piped water supply does your household use?	List of types!

Table 5, Indicators to "ACCESS"

Normative interpretation: Implies sufficient water to meet domestic needs is reliably available close to home	
Indicators	
NIF2.0	Percentage of Population getting safe and adequate drinking water within premises through Pipe Water Supply
New York	Water supply – Critical equipment out of service (%)
Questions	
How many hours per day is water supplied on average?	
Have you experienced limitation in water for drinking, cooking or personal hygiene? What was the (main) reason you were unable to access sufficient quantities of water when needed?	
Does your site/community have large storage tank(s)?	
How many liters does the storage tank hold?	
If you collect drinking water in your own container outside of the community how long does it take?	Including time taken for a single roundtrip, queuing and refilling time. Can be skipped if there is drinking water source within dwelling or yard.
What you do when you have no water? Do you bring the drinking water here? How, from how far? How big quantities?	

Table 6, Indicators and Questions to "SAFE"	
Normative interpretation: Safe drinking water is free from pathogens and elevated levels of toxic chemicals at all times	
Indicators	
Business	Quality level of drinking water
Business	Exposure to unsafe water quality and workers lacking access to drinking water.
New York	Samples testing positive for coliform bacteria (%)
New York	In-City samples meeting water quality standards for coliform bacteria
Shimokawa	Achievement rate of drinking water quality standards
Toyoma	Ratio of concrete pipes with measures against dilapidation
Questions	
Extent of replacement of pipes due to health risks (lead) PITSBURGH FROM TARGET	
Chemical (lead) data of water PITSBURGH FROM TARGET	
Money spent on pipes replacement due to health risk PITSBURGH FROM TARGET	
Do you have treated water available for drinking?	
What method do you use for treatment?	
Did you have a history of waterborne disease in the past 5 years Are there any indication of drinking water safety? Like history of water bourne diseases in the settlement? Diarrhea, etc?	
Do you know people who drink the water directly, without any treatment?	
How often do you check your water microbiological/chemical contamination	
Can you please give me the latest test report?	
Or Can I please check now: Number of E. coli detected in 100 mL sample water test	
Do you contain drinking water in small containers?	
Is your drinking water container sealed, it regularly cleaned and maintained?	
If you have a water filter or purifier, do you maintain/clean it?	
If you have a big water tank, do you maintain/clean/disinfect it?	This question is about the big storage capacities that stores water for drinking, cooking and personal hygiene and other purposes, not the small drinking water containers
Who provide maintenance to your small containers, big storage tanks, water purifiers and filters?	
Is the water supplied from your main source usually acceptable?	

Have you noticed any change in the water quality? If yes please specify:
What type of water pipes do you use? Did you or do you plan to change the water pipes due to health reasons?

Table 7, Indicators and Questions to "AFFORDABLE"	
Normative Interpretation: Payment for services does not present a barrier to access to or prevent people from meeting basic human needs	
Indicators	
Business	Estimated number of individuals who have improved access to an improved water source as a result of the initiative. As an example, this may include employees have improved access to water at the work site or consumers who purchase access to these services at a more affordable rate.
Business	Company water accounting - percentage of water being measured and monitored in company operations (global) - Current access to fully-functioning WASH services for all employees
Business	Investment in water and sanitation with private participation
Basque	Unit cost of water
Questions	
Financial assistance program (?USD) for those in need PITSBURGH FROM TARGET	
Do you pay for the water? Is your water contribution meter based? Is it maintenance based?	
Who covers the water costs? How do you share the water costs? Everyone pays equally? There is a type of support system? Etc? Do you find the cost of your water affordable?	

Table 8, Indicators and Questions to "DRINKING WATER"	
Normative Interpretation: Water used for drinking, cooking, food preparation and personal hygiene	
Indicator	
INindex2019	Percentage of households having improved source of drinking water
Business	Undertaken human-rights impact assessments and/or social and environmental impact assessments that explicitly consider water, to understand its actual and potential impacts particularly in water-stressed areas
Questions	
None	

Table 9, Indicators and Questions to "FOR ALL"	
Normative interpretation: Suitable for use by men, women, girls and boys of all ages, including people with disabilities	
Indicators	
Business	Percent of facilities with fully functioning WASH services for all workers
New York	Overall enforcement activity
La target inspired???	customer service for onsite old drinking water pipe maintenances
Questions	
Is the drinking publicly water available within the site? (check all options)	Private access means that drinking water is only available within households, open access means that a jar or fountain etc placed with glass for public access.
Is drinking water accessible to those with limited mobility or vision?	
Is drinking water accessible to women, men, girls and boys equally??	
Is drinking water accessible to the smallest children at the site (of a school)?	
how big is the capacity of the drinking water facilities/day (fountains)	

Table 10, Additional Indicators and Questions on SDG6.1	
LA target inspired	nr of freely accessible hydration stations with smart phone maps placed in the city
Do you restrict the use of plastic bottles? What measures do you do to reduce plastic waste of drinking water?	

SDG6.2: "**By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations.**"

Table 1: Indicators and Questions to "ACHIEVE ACCESS"	
Normative Interpretation: Implies facilities close to home that can be easily reached and used when needed	
Indicators	
Business	Distance between workplace premises and facilities
InIndia2018	Percentage of rural households with individual household toilets
InIndia2019	Percentage of urban households with individual household toilets
NIF2018	Proportion of households having access to toilet facility (Urban & Rural)
Questions	
Where is the toilet facility located? Within household or close proximity?	
Do you share this facility with others who are not members of your household?	

Table 2 Indicators and Questions to "ADEQUATE"	
Normative interpretation: Implies a system that hygienically separates excreta from human contact as well as safe reuse/treatment of excreta in situ, or safe transport and treatment off site	
Indicators	
Toyoma	Ratio of concrete pipes with measures against dilapidation
Toyoma	Proportion of population with sewage treatment
Shimokawa	Usage rate of flush toilet (%)
Shimokawa	Percentage with sewered population (%)
Questions	
What type of toilets/latrines are at the community? How the excreta is stored? Where? When is it emptied? Do you add EM to the toilet? Nr of composting toilets	

Table 3 Indicators and Questions to "EQUITABLE"	
Normative Interpretation: Implies progressive reduction and elimination of inequalities among population subgroups	
Indicators	
EUSTAT	Population having neither a bath, nor a shower, nor indoor flushing toilet in their household, (by annua growth rate, by country
Business	Investment in water and sanitation with private participation
Business	Undertaken human-rights impact assessments and/or social and environmental impact assessments that explicitly consider water, to understand its actual and potential impacts particularly in water-stressed areas
Business	Number of toilets/urinals provided (on the basis of a rate of 2 toilet seats and 2 urinal facilities per 45 male-workers and 3 toilet seats per 50 females)

Business	Estimated number of individuals who have improved access to an improved sanitation as a result of the initiative. As an example, this may include installing sanitation facilities at home or public areas.
Questions	
How many times per week are the public toilets cleaned?	
In general, how clean are the public toilets?	
How many toilets are available for the nr of users? Bathrooms, public/individual all public toilets and hand wash basins	

Table 4 Indicators and Questions to "SANITATION"	
Normative interpretation: The provision of facilities and services for safe management and disposal of human urine and faeces	
Indicators	
UNSTAT	Proportion of population using safely managed sanitation services, by urban/rural
UN	Proportion of population using safely managed sanitation service
Business	Company-wide water targets (quantitative) or goals (qualitative)- Increased access to Water, Sanitation and Hygiene Including: Motivation; Description of target; Quantitative unit of measurement; Baseline year; Target year; Proportion of target achieved;
Business	Description of company-wide water targets (quantitative) or goals (qualitative) and progress to date- Providing access to WASH in workplace- Providing access to WASH in local communities- Strengthen links w/local community Including: Motivation; Description; Progress
Questions	
Has your (pit latrine or septic tank) ever been emptied? What is the procedure?	
The last time it was emptied, where were the contents emptied to?	
Was it removed by a service provider?---- WHO???	
Does your sanitation facility leak or overflow wastes at any time of year?	
Where does your septic tank wastewater overflowdischarge to?	
How many years ago was your pit latrine/septic tank last emptied?	
How do you dispose of household grey water used for cooking, laundry and bathing?	

Table 5 Indicators and Questions to "HYGIENE"	
Normative interpretation: The conditions and practices that help maintain health and prevent spread of disease including hand-washing, menstrual hygiene management and food hygiene	
Indicators	
Business	Number of employees receiving hygiene training and awareness raising
UN	Proportion of population using a hand-washing facility with soap and water
UNSTAT	Proportion of population with basic hand-washing facilities on premises, by urban/rural
Questions	
Are both soap and water currently available at the hand-washing facilities?	
Where are your hand-washing facilities located?------ DO YOU HAVE? HOW MANY?	
Do you receive regular hygiene inspections and trainings on the site?	

Table 6 Indicators and Questions to "FOR ALL"	
Normative interpretation: Suitable for use by men, women, girls and boys of all ages, including people with disabilities	
Indicators	
Business	Worksite has separate toilet facility for women

Business	Current access to fully-functioning WASH services for all employees
Questions	
Does the design of your toilet prevent other people seeing and hearing what you are doing when you use it?	
Is the toilet lockable from the inside? Percentage of woman/man toilet public safe space for women hygenie How many women/men toilets are on the site? Are there women/men on site?	
Is there at least one usable toilet that is accessible to the smallest children (of the school)?	
Is there at least one usable toilet that is accessible to those with limited mobility or vision?	
Are there hand-washing facilities accessible to those with limited mobility or vision?	
Are there hand-washing facilities accessible to the smallest children (of the school)?	

Table 7 Indicators and Questions to "END OPEN DEFECATION"	
Normative interpretation: Excreta of adults or children are: deposited (directly or after being covered by a layer of earth) in the bush, a field, a beach or any other open area; discharged directly into a drainage channel, river, sea or any other water body; or are wrapped in temporary material and discarded	
Indicators	
UNSTAT	Proportion of population practicing open defecation, by urban/rural
NIF2018	Percentage of Districts achieving Open Defecation Free (ODF) target.
Questions	
Is there any trace of open defecation on the site? (compost toilet is NOT ODF!)	
Is it known/suspected that some people do open defecation on the site? Open Defecation on construction sites and seasonal workers farms	

Table 8, Indicators and Questions to "NEEDS OF WOMEN AND GIRLS"	
Normative Interpretation: Implies reducing the burden of water collection and enabling women and girls to manage sanitation and hygiene needs with dignity. Special attention should be given to the needs of women and girls in high-use settings such as schools and workplaces, and high-risk settings such as health-care facilities and detention centres	
Indicators	
Business	Worksite has separate toilet facility for women
NIF2018	Proportion of schools with separate toilet facility for girls
Questions	
LA inspired	Measurements on non degradable sanitary waste management
During your last menstrual period were you able to wash and change in privacy while at home?	
During your last menstrual period, what hygiene materials did you use?	
Were these materials reusable?	
Which of the following provisions for menstrual hygiene management (MHM) are available at site/community?	
Bathing areas	
MHM materials (e.g. pads)	
MHM education	
Are water and soap available in a private space for women and girls to manage menstrual hygiene?	
Are there covered bins for disposal of menstrual hygiene materials in girls' toilets?	
Are there disposal mechanisms for menstrual hygiene waste at the school?	
How does your household usually dispose of garbage? Is it done by a service provider?	
How do you terat no decomposing toilet wastes? Do you have a procedure to avoid it to get into the waste water?	

SDG6.3

Table 1, Indicators and Questions to "IMPROVE WATER QUALITY"	
Normative interpretation: Implies achieving adequate quality of receiving water bodies so that they do not present risks to the environment or human health.	
Indicators	
UN	Proportion of bodies of water with good ambient water quality
UNSTAT	Proportion of groundwater bodies with good ambient water quality
UNSTAT	Proportion of open water bodies with good ambient water quality
UNSTAT	Proportion of river water bodies with good ambient water quality
EUSTAT	Biochemical oxygen demand in rivers, (mg O2 per litre), Compound annual growth rate (CAGR) of the biochemical oxygen demand in rivers,
EUSTAT	Nitrate in groundwater, (mg NO3 per litre)
EUSTAT	Phosphate in rivers, EU, (mg PO4 per litre), Compound annual growth rate (CAGR) of the phosphate in rivers,
New York	Harbor survey stations meeting the fishable standard of 5mg/L for dissolved oxygen (%) Description: The City collects and tests water samples from 35 harbor survey stations in the water bodies surrounding New York City. This indicator represents the percent of these stations that were in compliance with the 5mg/L fishable standard for the amount of dissolved oxygen. The New York State Department of Environmental Conservation classifies water bodies and establishes water quality standards depending on the classification of the water body. The 5mg/L for dissolved oxygen threshold is the State's "fishable" standard for dissolved oxygen.
Business	Percent of facilities adhering to relevant water quality standard(s)
Questions	
Are there receiving water bodies such as an ocean, stream, river, pond, lake, or another such body of water into which treated or untreated wastewater or effluent is discharged.? If not what happens to the wastewater? Pollution of water on premises What is the quality of the site's permanent surface water bodies? Chemical parameters: Data on water qualities of borewell, ponds, any data collection ever happened?	

Table 2, Indicators and Questions for "REDUCING POLLUTION"	
Normative interpretation: Implies minimizing the generation of pollutants at source and reducing the discharge of polluting substances from point sources (for example, wastewater outlets from economic activities and households) and non-point sources (for example, urban and agricultural runoff)	
Business	Quality of storm water by applicable regulatory standards
Business	Number of process safety events, by business activity
Business	Total amounts of overburden, rock, tailings, and sludges and their associated risks
Business	Total water discharge by quality and destination
Business	Company water accounting - % of water being measured and monitored in company operations (global)- Water discharge quality data - quality by standard effluent parameter
Business	Company-wide water targets (quantitative) or goals (qualitative)- Reduction in wastewater- Water pollution prevention Including: Motivation; Description of target; Quantitative unit of measurement; Baseline year; Target year; Proportion of target achieved; % value
Questions	
Chemical use guide lines on reducing pollution via cleaning agents and beauty products? How do you treat urban run of/vehicle pollution? Do you practice organic agriculture and gardening, or do you use non organic chemicals? How do you lower pollution from Agriculture, Urban runoff, Wastewater outlets?	

Table 3, Indicators and Questions for "ELIMINATING DUMPING"	
Normative interpretation: Implies ending all inadequate disposal of waste (solid and liquid, for example, leachates from poorly managed solid waste)	
Indicators	
Business	Amount of drilling waste (drill mud and cuttings) and strategies for treatment and disposal
Business	Total weight of waste by type and disposal method
Business	Volume and disposal of formation or produced water
Business	Company water discharges - total water discharge data by destination, across operations, including: Destination; Quantity (megaliters/year); YOY comparison of total water discharged to this destination
Business	Total weight of non-hazardous waste, with a breakdown by the following disposal methods where applicable: i. Reuse ii. Recycling iii. Composting iv. Recovery, including energy recovery v. Incineration (mass burn) vi. Deep well injection vii. Landfill viii. On-site storage ix. Other (to be specified by the organization)
Questions	
What happens to the sludge, waster water? Where it goes?	
What happens to compost toilet compost?	
Any leachets?	
How do you collect garbage/solid waste?	
How do you recycle, decrease solid waste?	
Do you compost organic waste?	
How do you achieve zero waste?	
How do you reduce plastic waste? How do you change consumption habits, Do you offer non packaged items in local stores?	
What % do you recycle or landfill your waste?	
What awareness rising you do for zero waste?	

Table 4, Indicators and Questions to "MINIMIZING RELEASE OF HAZARDOUS CHEMICALS AND MATERIALS"	
Normative interpretation: Implies reducing the generation, use and discharge of hazardous substances, as defined and listed in the conventions of Basel, Rotterdam and Stockholm	
Indicators	
NIF2018	Percentage of industries (17 category of highly polluting industries/grossly polluting industry/red category of industries) complying with wastewater treatment as per CPCB norms.
Business	Impacts of significant spills. Number of spills/tons
Business	Total number and total volume of recorded significant spills.
Business	The following additional information for each spill that was reported in the organization's financial statements: i. Location of spill; i. Volume of spill; ii. Material of spill, categorized by: oil spills (soil or water surfaces), fuel spills (soil or water surfaces), spills of wastes (soil or water surfaces), spills of chemicals (mostly soil or water surfaces), and other (to be specified by the organization).
Business	Total weight of hazardous waste, with a breakdown by the following disposal methods where applicable: i. Reuse ii. Recycling iii. Composting iv. Recovery, including energy recovery v. Incineration (mass burn)vi. Deep well injection vii. Landfill viii. On-site storage ix. Other (to be specified by the organization)
Business	Number (and percentage) of company operating sites where artisanal and small-scale mining (ASM) takes place on, or adjacent to, the site; the associated risks and the actions taken to manage and mitigate these risks
Questions	
Hazardous Chemicals? How do you treat them? No hazardous chemicals are released into the water.	
Do you have any industrial unit from the 17 highly polluting types? What are their technologies? Do they work with hazardous materials? If yes how do they treat them?	
Do you use hazardous waste? How do you treat/process them?	

Table 5, Indicators and Questions to "Halving the proportion of untreated wastewater"	
Normative interpretation: Implies halving the proportion of wastewater that is untreated, generated by households and all economic activities (based on International Standard Industrial Classification (ISIC) Rev. 4); some economic activities are of special relevance due to high wastewater generation, including agriculture, mining and quarrying, manufacturing, electricity and sewerage. Treatment implies any process for rendering wastewater fit to meet applicable environmental standards or other quality norms; treatment can be categorized into primary, secondary and tertiary treatments (and further by mechanical, biological, and advanced technology treatments). Discarded water that is no longer required by the owner or user, including discharges to drains or sewers for treatment or direct discharges into the environment, as well as water reused by another user without further treatment	
Indicators	
Business	Wastewater treatment level weighted by connection to wastewater treatment rate
NIF2018	Percentage of sewage treated before discharge into surface water bodies
NIF2018	Proportion of waste water treatment capacity created vis-à-vis total generation
IIndex2018	Installed sewage treatment capacity as a proportion of sewage generated in urban areas
UN	Proportion of wastewater safely treated
UNSTAT	Proportion of safely treated domestic wastewater flows
EUSTAT	Population connected to at least secondary wastewater treatment, (% of population)
New York	Wastewater treatment plant (WWTP) effluent meeting federal standards (%) Description: The percent of treated wastewater leaving in-City treatment plants that meets federal standards for suspended solids and biochemical oxygen demand
Questions	
Do you have data on the quantity and quality of wastewater? monitored waste water quality treated, untreated any data? How do you treat waste water? Wastewater treatment facility NR of installed sewage treatment systems Type of sewage treatment methods, capacity of sewage treatment Capacity of waste water Nr of settlements without sewage treatment	

Table 6, Indicators and Questions to "Increasing recycling"	
Normative interpretation: Implies increasing the on-site reuse of water within the same establishment or industry	
Indicators	
Business	Wastewater Produced, collected, treated municipal wastewater Number of municipal wastewater treatment facilities Capacity of the municipal wastewater treatment facilities Not treated municipal wastewater Treated and not treated municipal wastewater discharged (secondary water) Direct use of treated municipal wastewater Direct use of treated, and not treated municipal wastewater for irrigation purposes Area equipped for irrigation by direct use of treated and not treated municipal wastewater
Business	Water withdrawal by source: Fresh surface water withdrawal (primary and secondary) Fresh groundwater withdrawal (primary and secondary) Total freshwater withdrawal (primary and secondary) Desalinated water produced Direct use of treated municipal wastewater Direct use of agricultural drainage water
Business	Total volume of water recycled by the organization.
Business	Total volume of water recycled as a percentage of the total water withdrawal
Business	Percentage and total volume of water recycled
Questions	
Is wastewater recycled? For what purpose? Sludge decomposed? Grey-black water separation?	

Table 6, Indicators and Questions to "Safe"
Normative interpretation: Implies water has undergone sufficient treatment, combined with non-treatment barriers to protect human health, for the intended use (as described in the 2006 WHO Guidelines for safe use of wastewater, excreta and greywater
Indicators

none	

Questions
What procedures, technologies ensure the safe recycle or reuse of waste water? To not endanger drinking or other water quality?

Table 7, Indicators and Questions to "REUSE"	
Normative interpretation: Implies wastewater supplied to a user for further use, with or without prior treatment (for example, use of household wastewater in agriculture), excluding the recycling of water within the same establishment	
Indicators	
Business	Total volume of planned and unplanned water discharges by: i. Destination; ii. Quality of the water, including treatment method; iii. Whether the water was reused by another organization.
Business	Total volume of water reused by the organization.
Business	Total volume of water reused as a percentage of the total water withdrawal
Business	Percentage and total volume of water reused
Questions	
reuse of untreated waste water modes of treated waste water reuse or recycle?	

Table 8, Indicators and Questions to "GLOBALLY"
Normative interpretation: Implies increased recycling and safe reuse at the global scale, allowing for differentiated efforts at the national and regional scales, focusing efforts on water-scarce regions
Indicators
none
Questions
How do you dela with non decomposable toilet waste?

Table 9, Additional Indicators on SDG6.3	
Business	Water performance in the value chain
Business	Total renewable water resources Total renewable surface water Total renewable groundwater Overlap: between surface water and groundwater Total renewable water resources Dependency ratio
Business	Pressure on water resources˜ Freshwater withdrawal as % of total renewable water resources Agricultural water withdrawal as % of total renewable water resources
Business	Amount of land (owned or leased, and managed for production activities or extractive use) disturbed or rehabilitated
Business	Land remediated and in need of remediation for the existing or intended land use, according to applicable legal designations
New York	WWTPs – Critical equipment out-of-service (% below minimum) Description: There are certain types of equipment at wastewater treatment plants, such as main sewage pumps, that are critical to the treatment of sewage. For each of these equipment types, each of the City's 14 wastewater treatment plants establishes the minimum number which must be in service in order to treat the industry standard of two times dry weather flow. This indicator reports the total number of unit types that were below the required number at any time during the month as a percent of total critical equipment units (the aggregate of number and type).

6.4

Table 1, Indicators and Questions to "BY 2030, SUBSTANTIALLY INCREASE WATER-USE EFFICIENCY "
Normative interpretation: Implies maximizing the productivity of economic activities while minimizing their water use(generating more output per input of water, including by reducing water losses); closely related to the concept of sustainable production and consumption
Indicators

UN	Change in water-use efficiency over time
UNSTAT	Water Use Efficiency (United States dollars per cubic meter)
Business	Water productivity
Business	Water consumption per net value added
Business	Location-specific data: Water intensity
Business	Water performance in the value chain
Business	Determination of the proportion of water consumption in operations vs. water consumption in supply chain
Questions	
Do you have information on the income generated and the used water / year? Accountable! Water use efficiency	

Table 2, Indicators and Questions to "ACROSS ALL SECTORS"	
Normative interpretation: All economic activities (based on ISIC Rev. 4 categories); some industries are of special relevance due to high water use, including agriculture, mining and quarrying, manufacturing, electricity, and water collection, treatment and supply	
Indicators	
Business	Building water intensity
Business	Company water governance - companies with water policy- Commitment to customer education
Business	Set a specific target to reduce water use in direct operations
Business	Description of company-wide water targets (quantitative) or goals (qualitative) and progress to date- Educate customers to help them minimize product impacts- Engagement with public policy makers to advance sustainable water policies and management Including: Motivation; Description; Progress
Business	Does the Company system have procedures or systems in place to help reduce its footprint on water? (for instance, seeking alternative water sources, such as grey water or rainwater capture systems)?
Questions	
Water use communal	
Water use in the industrial purposes	
Water use agricultural	
How do you lower water use in Agriculture, Industry, Domestic?	
farming technologies for water efficiency please select	
grey water reuse…	

Table 3, Indicators and Questions to "AND ENSURE SUSTAINABLE WITHDRAWALS "	
Normative interpretation: Implies that water withdrawals do not lead to permanent depletion of water bodies, taking environmental water requirements into account	
Indicators	
NIF2018	Percentage ground water withdrawal against net annual availability
EUSTAT	Water exploitation index plus (WEI+), (% of renewable water resources)
Business	Location-specific data: Water withdrawals by source type
Business	Total and percentage of withdrawals in water-stressed or water-scarce areas
Business	Total water withdrawal by source
Business	Water sources significantly affected by withdrawal of water
Business	Water withdrawals: for the reporting year, with water accounting data for all facilities
Business	Water withdrawals: for the reporting year, please provide total water withdrawal data by source, across your operations
Business	Water withdrawals: for the reporting year, please provide withdrawal data, in megaliters per year, for the water sources used for all facilities reported

Business	Water consumption: for the reporting year, please provide total water consumption data, across your operations
Business	Water consumption: for the reporting year, please provide water consumption data for all facilities reported
Business	Company water accounting - total water withdrawal data by source, across company operations- Fresh surface water Including: Quantity (megaliters/year); comparison w/last reporting year;
Business	Company water consumption - total water consumption data- Consumption (megaliters/year); comparison to previous year
Business	Company water withdrawals (facility level) - water accounting data for all facilities- Facility reference number; Country; River basin; Facility name; Total water withdrawals (megaliters / year) at this facility; comparison with previous year
Business	Company water withdrawals (facility level) - withdrawal data (megaliters per year) for the water sources used for all facilities- Facility reference number; Fresh surface water
Business	Total volume of water withdrawn, with a breakdown by the following sources: i. Surface water, including water from wetlands, rivers, lakes, and oceans; ii. Ground water; iii. Rainwater collected directly and stored by the organization; iv. Waste water from another organization; v. Municipal water supplies or other public or private water utilities.
Business	Company water consumption (facility level) - water consumption data for all facilities
Business	Total number of water sources significantly affected by withdrawal by type:i. Size of the water source;ii. Whether the source is designated as a nationally or internationally protected area; iii. Biodiversity value (such as species diversity and endemism, and total number of protected species);iv. Value or importance of the water source to local communities and indigenous peoples.
Business	Company-wide water targets (quantitative) or goals (qualitative)- Absolute reduction of water withdrawals- Reduction in consumptive volumes- Reduction in wastewater Including: Motivation; Description of target; Quantitative unit of measurement; Baseline year; Target year; Proportion of target achieved; % value
Business	Location-specific data: Water consumption
Questions	
All water use and purpose, measurement (water tank size, how often refilled…	
Fresh water withdrawal history data, observations	
Nr of borewells on site, their history	
percentage of annual ground water withdrawal	
how do you control water withdrawal?	

Table 4, Indicators and Questions to "AND SUPPLY OF FRESHWATER"	
Normative interpretation: Naturally occurring water with a low concentration of salts, or generally accepted as suitable for abstraction and treatment to produce potable water (to compare with brackish and marine water – defining salinity concentrations varies among countries); the definition of inland water resources includes both freshwater and brackish water, categorized as surface water, groundwater and soil water	
Indicators	
NIF2018	Per capita storage of water(m3/person)
NIF2018	Per capita availability of water (m3/person)
Questions	
How do you store water?	
How big water tanks, and how many people using them, Per capita storage of water	
Rainwater catchment tanks	

Table 5, Indicators and Questions to "TO ADDRESS WATER SCARCITY"	
Normative interpretation: The point at which the aggregate impact of all users impinges on the supply or quality of water, to the extent that, under prevailing institutional arrangements, the demand by all sectors, including the environment, cannot be fully satisfied; physical water scarcity prevails when more than 75% of available water resources is withdrawn; economic water scarcity prevails when malnutrition exists, although less than 25% of available water resources is withdraw	
Indicators	
UN	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

UNSTAT	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (%)
Business	Average water intensity in water-stressed or water-scarce areas
Business	Number of premises under direct control where water saving technologies and water saving awareness campaign are employed in areas facing water scarcity or water stress
Questions	
Salt water intrusion Changes in water quality due to water scarcity… (ph, hardness, salinity, sodium) Drop in water level? Borewell depth data, observations	

Table 6, Indicators and Questions to "AND SUBSTANTIALLY REDUCE THE NUMBER OF PEOPLE SUFFERING FROM WATER SCARCITY"	
Normative interpretation: Implies targeting physical and economic water scarcity to reduce its impact on people, for example, by helping those suffering from malnutrition	
Indicators	
Business	Conduct community consultation on water-stress assessments or sustainability assessments of shared water sources
Business	Require fair compensation and grievance mechanisms in case water rights have been violated and/or relinquished
Business	Undertaken human-rights impact assessments and/or social and environmental impact assessments that explicitly consider water, to understand its actual and potential impacts particularly in water-stressed areas
Questions	
Have you experienced water stress in the past years? Have you overcome them? How?How do you prioritize needs during water stress period within the premises What solutions have you explored/developed against water scarcity?	

Table 7, Additional Indicators on SDG6.4	
Business	Percentage and total volume of water recycled and reused
Business	Total volume of water recycled and reused by the organization.
Business	Total volume of water recycled and reused as a percentage of the total water withdrawal as specified in Disclosure 303-1.
Business	Total volume of planned and unplanned water discharges by: i. Destination; ii. Quality of the water, including treatment method; iii. Whether the water was reused by another organization.
Business	Company water discharge (facility level) - water accounting data for all facilities
Business	Company water discharge (facility level) - water discharge data (in megaliters / year) by destination for all facilities
Business	Volume and disposal of formation or produced water
Business	Type and number of sustainability certification, rating and labeling schemes for new construction, management, occupation and redevelopment
Business	Extent of impact mitigation of environmental impacts of products and services
Business	Company water accounting - % of water being measured and monitored in company operations (global)- Water aspect; % of sites/ facilities/ operations

Table 8, Additional Questions on SDG6.4
Energy that s needed to access to water (electric, solar, wind, human powered, etc) How is it provided?

SDG6.5

Table 1, Indicators and Questions to "BY 2030, IMPLEMENT"
Normative interpretation: Refers to the Johannesburg Plan of Implementation (2002) objective to develop IWRM and water efficiency

plans
Indicators
none
Questions
none

Table 2, Indicators and Questions to "INTEGRATED WATER RESOURCES MANAGEMENT**"**	
Normative interpretation: Process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems, taking into account hydrological and technical aspects, as well as socioeconomic, political and environmental dimensions	
Indicators	
NIF2018	Percentage area of river basins brought under integrated water resources management
UN	Degree of integrated water resources management implementation (0–100)
UNSTAT	Degree of integrated water resources management implementation (%)
UNSTAT	Proportion of countries by IWRM implementation category (%)
Questions	
any practice of IWRM	
Integrated water management IWRM is implemented, documented.	
Committee person in charge of IWRM	
How do you lower groundwater dependence	
Rainwater per year (mm) size of the community (ha), potential quantity of rainwater on site?	

Table 3, Indicators and Questions to "AT ALL LEVELS"
Normative interpretation: Refers primarily to vertical levels of governance, from national government to local government, basin authorities and stakeholder participation
Indicators
none
Questions
size of built up/ covered areas (no prelocation)
How do you manage the water in your basin?
How do you recharge ground water?
What water catchment water retentive practices do you use?
Ground water refilling, nr/size/percentage of prelocative ponds
Technologies for zero run off
Achievement of zero run off

Table 4, Indicators and Questions to "INCLUDING THROUGH TRANSBOUNDARY"	
Normative interpretation: Surface water or groundwater basins (aquifers) that cross or are located on boundaries among two or more countries; refers to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) and the Convention on the Law of the Non navigational Uses of International Watercourses (New York, 1997)	
Indicators	
UN	Proportion of transboundary basin area (*with an operational arrangement for water cooperation)*
UNSTAT	Proportion of transboundary aquifers (*with an operational arrangement for water cooperation (%))*
UNSTAT	Proportion of transboundary basins (river and lake basins and aquifers) (*with an operational arrangement for water cooperation*)

UNSTAT	Proportion of transboundary river and lake basins (*with an operational arrangement for water cooperation (%)*)
Questions	
transboundary water basin/catchment area	
Transboundary ponds	
transboundary canyons	
other transboundary elements (kolam?)	
neighbours information	

Table 5, Indicators and Questions to "COOPERATION AS APPROPRIATE"	
Normative interpretation: Customary international water law requires countries to cooperate in managing transboundary waters, with the main principles contained in the above-mentioned United Nations conventions; apart from island countries without a terrestrial border or countries not having transboundary waters, transboundary water cooperation is appropriate	
Indicators	
UN	Proportion of transboundary basin area with an operational arrangement for water cooperation
UNSTAT	Proportion of transboundary aquifers with an operational arrangement for water cooperation (%)
UNSTAT	Proportion of transboundary basins (river and lake basins and aquifers) with an operational arrangement for water cooperation (%)
UNSTAT	Proportion of transboundary river and lake basins with an operational arrangement for water cooperation (%)
Questions	
Transboundary water related conflicts	
Transboundary water related cooperations	
transboundary water basin/catchment area – conflict/cooperation?	
Transboundary ponds – conflict/cooperation?	
Canyons conflict/cooperation?	
Waste water from neighbors conflict/cooperation?	
Monsoon extra water flow, conflict/cooperation?	
Water stress issues with neighbors borewells conflict/cooperation?	

SDG6.6

Table 1, Indicators and Questions to "BY 2020"
Normative interpretation: Refers to the Aichi Biodiversity Targets to be reached by 2020
Indicators
none
Questions
Have you achieved the AICHI targets by 2020?

Table 2, Indicators and Questions to "protect and"	
Normative interpretation: Implies a reduction in or eradication of the loss or degradation of ecosystems	
Indicators	
Business	Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the organization's discharges of water and runoff
Business	The number and percentage of total sites identified as requiring biodiversity management plans according to stated criteria, and the number (percentage) of those sites with plans in place
Business	For each operational site owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside

	protected areas, the following information: i. Geographic location; ii. Subsurface and underground land that may be owned, leased, or managed by the organization; iii. Position in relation to the protected area (in the area, adjacent to, or containing portions of the protected area) or the high biodiversity value area outside protected areas; iv. Type of operation (office, manufacturing or production, or extractive);v. Size of operational site in km2 (or another unit, if appropriate);vi. Biodiversity value characterized by the attribute of the protected area or area of high biodiversity value outside the protected area (terrestrial, freshwater, or maritime ecosystem);vii. Biodiversity value characterized by listing of protected status (such as IUCN Protected Area Management Categories, Ramsar Convention, national legislation).
Business	Amount of land (owned or leased, and managed for production activities or extractive use) disturbed or rehabilitated
Business	Total number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk
Business	Biodiversity of offset habitats compared to the biodiversity of the affected areas
Business	Trends in population and extinction risk of utilized species, including species in trade
Business	Threatened bird, fish, mammal and plant species
Business	Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas
Business	Number and percentage of significant operating sites in which biodiversity risk has been assessed and monitored
Business	Operational sites owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas
Business	Terrestrial and marine protected areas
Business	Company water risk assessment - contextual issues factored in- current status of ecosystems and habitats at local level- Estimates of future potential changes in the status of ecosystems and habitats at a local level- Scenario analysis of potential changes in the status of ecosystems and habitats at a local level
Business	Total number of IUCN Red List species and national conservation list species with habitats in areas affected by the operations of the organization, by level of extinction risk: i. Critically endangered ii. Endangered iii. Vulnerable iv. Near threatened v. Least concern
Business	Nature of significant direct and indirect impacts on biodiversity with reference to one or more of the following: i. Construction or use of manufacturing plants, mines, and transport infrastructure; ii. Pollution (introduction of substances that do not naturally occur in the habitat from point and non-point sources);iii. Introduction of invasive species, pests, and pathogens; iv. Reduction of species; v. Habitat conversion; vi. Changes in ecological processes outside the natural range of variation (such as salinity or changes in groundwater level).
Business	Significant direct and indirect positive and negative impacts with reference to the following: i. Species affected; ii. Extent of areas impacted; iii. Duration of impacts; iv. Reversibility or irreversibility of the impacts.
Business	Habitats protected
Business	Size and location of all habitat areas protected
Questions	
How do you protect? What principles, policies are to protect nature?	
Do you do environment impact assessment before building/development?	
size of full area	
Biodiversity indexes, Wildlife, biodiversity	
Building allocations within sites, disperse or concentrated	
Size of continuous park, garden, habitat with little human presence, undisturbed by humans	

Table 3, Indicators and Questions to "RESTORE"	
Normative interpretation: Implies a reversal of loss or degradation; assisting the recovery of degraded, damaged or destroyed ecosystems by re-establishing structural characteristics, species composition and ecological processes	
Indicators	
Business	Habitats restored
Business	Land remediated and in need of remediation for the existing or intended land use, according to applicable legal designations
Business	Size and location of all habitat areas restored, and whether the success of the restoration measure was or is approved by independent external professionals.

Questions
How the nature/landscape/flora and fauna changed since you moved in? How have you impacted BDI?
Do you have any restoration project in progress now? What NRS, values? (size, species, etc)

Table 4, Indicators and Questions to "WATER-RELATED ECOSYSTEMS"	
Normative interpretation: Whereas all ecosystems depend on water, some ecosystems – as specified below – play a more prominent role in the provision of water-related services to society	
Indicators	
UN	Change in the extent of water-related ecosystems over time
UNSTAT	Nationally derived extent of open water bodies (square kilometres)
UNSTAT	Nationally derived proportion of water bodies with good quality (%)
UNSTAT	Nationally derived quality of open water bodies(%)
UNSTAT	Nationally derived quantity of open water bodies (million of cubic metres per annum)
UNSTAT	Nationally derived total extent (square kilometres)
UNSTAT	Nationally derived total quantity (millions of cubic metres per annum)
UNSTAT	Water body extent (permanent and maybe permanent) (% of total land area)
UNSTAT	Water body extent (permanent and maybe permanent) (square kilometres)
UNSTAT	Water body extent (permanent) (% of total land area)
UNSTAT	Water body extent (permanent) (square kilometres)
NIF2018	Biological assessment information of surface water bodies.
Business	Total number and total volume of recorded significant spills.
Business	Total amounts of overburden, rock, tailings, and sludges and their associated risks
Business	Total water discharge by quality and destination
Business	Water bodies affected by water discharges and/or runoff
Business	Total volume of planned and unplanned water discharges by: i. Destination; ii. Quality of the water, including treatment method; iii. Whether the water was reused by another organization.
Business	a. Water bodies and related habitats that are significantly affected by water discharges and/or runoff, including information on: i. The size of the water body and related habitat; ii. Whether the water body and related habitat is designated as a nationally or internationally protected area; iii. The biodiversity value, such as total number of protected species.
Business	Environment Area salinized by irrigation % of area equipped for irrigation salinized Area waterlogged by irrigation Flood occurrence (WRI)
Questions	
Built up %?	
Parks	
lawns	
size of organic farms	
map with the different type of lands	
type of ecosystems and size	

Table 5, Indicators and Questions to "INCLUDING MOUNTAINS"	
Normative interpretation: Most of the world's rivers are fed from mountain sources, with snow acting as a storage mechanism for downstream users; more than half of humanity depends on mountains for water	
Indicators	
Business	Number (and percentage) of company operating sites where artisanal and small-scale mining (ASM) takes place on, or adjacent to,

	the site; the associated risks and the actions taken to manage and mitigate these risks
Questions	
none	

Table 6, Indicators and Questions to "FORESTS"
Normative interpretation: Large areas of land covered with trees or other woody vegetation, covering about 30% of the world's land area and accounting for 75% of gross primary production; forests are central for safeguarding water quantity and quality
Indicators
Included in ecosystems table 4
Questions
size of forests Forest on site Type of forest, BDI?

Table 7, Indicators and Questions to "WETLANDS"	
Normative interpretation: Swamp, pond, peat or water, natural or artificial, permanent or temporary, stagnant or flowing water, including estuaries and marine waters down to 6 m below the low-tide mark (definition by the Ramsar Convention)	
Indicators	
UNSTAT	Extent of human made wetlands (square kilometres)
UNSTAT	Extent of inland wetlands (square kilometres)
UNSTAT	Nationally derived extent of wetlands (square kilometres)
Questions	
Ant channels? Artificial ponds ecosystems size of permanent or temporary wetlands Reed beds? Wetlands? Size, BDI? Water quality?	

Table 8, Indicators and Questions to "RIVERS"	
Normative interpretation: Channels where water flows continuously or periodically	
Indicators	
NIF2018	Percentage sewage load treated in major rivers
UNSTAT	Nationally derived extend of rivers (square kilometres)
UNSTAT	Nationally derived quality of river(%)
UNSTAT	Nationally derived quantity of rivers (million of cubic metres per annum)
Business	Company water risk assessment - Number of company facilities per river basin exposed to water risks that could generate a substantive change in business, operations, revenue or expenditure and the proportion this represents of total operations company-wide- Country; River basin; Number of facilities exposed to water risk; Proportion of total operations company-wide (%)
Questions	
Rivers, size, water quality, BDI?	

Table 9, Indicators and Questions to "AQUIFERS"
Normative interpretation: Underground zones that contain sufficient saturated permeable material to yield significant quantities of water to wells and springs
Indicators

UNSTAT	Nationally derived quality of groundwater (%)
UNSTAT	Nationally derived quantity of groundwater (millions of cubic metres per annum)
NIF2.0	Percentage of blocks/mandals/taluka over- exploited, (in percentage)
NIF2018	Area under over-exploited blocks
Questions	
Quality of groundwater?	

Table 10, Indicators and Questions to "LAKES"
Normative interpretation: Depressions in the Earth's surface occupied by bodies of standing water; they also include small and shallow water bodies, such as ponds and lagoons
Indicators
Included in ecosystems table 4
Questions
Ponds eco systems, quality, size, BDI?

Table 11, Additional Indicators on SDG6.6	
Indicators	
Business	Company water risk assessment - Companies w/exposure to water risks, either current and/or future, that could generate a substantive change in business, operations, revenue or expenditure
Business	Company water targets - Description of company-wide water targets (quantitative) or goals (qualitative) and progress to date- Watershed remediation and habitat restoration, ecosystem preservation Including: Motivation; Description; Progress
Business	Whether partnerships exist with third parties to protect or restore habitat areas distinct from where the organization has overseen and implemented restoration or protection measures.
Business	Total number and volume of significant spills
Business	Impacts of significant spills.
Business	The following additional information for each spill that was reported in the organization's financial statements: i. Location of spill; ii. Volume of spill; iii. Material of spill, categorized by: oil spills (soil or water surfaces), fuel spills (soil or water surfaces), spills of wastes (soil or water surfaces), spills of chemicals (mostly soil or water surfaces), and other (to be specified by the organization).
Questions	
Organic agriculture size? BDI? Pastures size? BDI?	

SDG6.A

Table , Indicators and Questions to "BY 2030, EXPAND INTERNATIONAL COOPERATION"	
Normative interpretation: Implies aid in the form of grants or loans from external support agencies	
Indicators	
none	
UN	Amount of water- and sanitation-related official development assistance that is part of a government coordinated spending plan
UNSTAT	Total official development assistance (gross disbursement) for water supply and sanitation, by recipient countries (millions of constant 2018 United States dollars)
NIF2018	Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan
Questions	
Financial assistance, participation in grants, collaborations in projects?	

Table , Indicators and Questions to "AND CAPACITY BUILDING SUPPORT TO DEVELOPING COUNTRIES"	
Normative interpretation: Implies strengthening the skills, competencies and abilities of people and communities, so that they can overcome the causes of their exclusion and suffering	
Indicators	
NIF2018	Number of MoU/Co operation agreements for capacity building and technology transfer
Questions	
Trainings on site?	
Knowledge sharing web based?	
Cooperation with universities, training institutes, Training for workers, volunteers	
Knowledge sharing with organizations, institutes, individuals, governments?	

Table , Indicators and Questions to "IN WATER- AND SANITATION-RELATED ACTIVITIES AND PROGRAMMES, INCLUDING WATER HARVESTING, DESA LINATION, WATER EFFICIENCY, WASTEWATER TREATMENT, RECYCLING AND REUSE TECHNOLOGIES"
Normative interpretation: Practices, processes and technologies that support progress towards water- and sanitation-related targets; the monitoring of water and sanitation, including observation networks and databases for surface and groundwater, is also important
Indicators
none
Questions
Technologies developed and shared on SDG6.1-6?
How do you share your accumulated knowledge and experience on SDG6.1-6?

SDG6.B

Table 1, Indicators and Questions to "SUPPORT AND STRENGTHEN THE PARTICIPATION OF"	
Normative interpretation: Participation implies a mechanism by which individuals and communities can meaningfully contribute to decisions and directions on water and sanitation planning that affect or can be affected by them	
Indicators	
NIF2018	Proportion of villages with Village Water & Sanitation Committee
UN	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management
UNSTAT	Proportion of countries with clearly defined procedures in law or policy for participation by service users/communities in planning program in rural drinking-water supply
UNSTAT	Proportion of countries with clearly defined procedures in law or policy for participation by service users/communities in planning program in water resources planning and management
UNSTAT	Countries with procedures in law or policy for participation by service users/communities in planning program in rural drinking-water supply, by level of definition in procedures (10 = Clearly defined; 5 = Not clearly defined ; 0 = NA)
UNSTAT	Countries with procedures in law or policy for participation by service users/communities in planning program in water resources planning and management, by level of definition in procedures (10 = Clearly defined; 5 = Not clearly defined ; 0 = NA)
Questions	
administrative group on water	
documents on water, data collection and data sharing on water	
water metered	
how are water supply maintenance costs administered?	
who covers cost: users, income generator, mixed?	

Table 2, Indicators and Questions to "LOCAL COMMUNITIES"	
Normative interpretation: Groups of interacting people living in a common location	
Indicators	
none	
UNSTAT	Proportion of countries with high level of users/communities participating in planning programs in rural drinking-water supply
UNSTAT	Proportion of countries with high level of users/communities participating in planning programs in water resources planning and management
UNSTAT	Countries with users/communities participating in planning programs in rural drinking-water supply, by level of participation (3 = High; 2 = Moderate; 1 = Low; 0 = NA)
UNSTAT	Countries with users/communities participating in planning programs in water resources planning and management, by level of participation (3 = High; 2 = Moderate; 1 = Low; 0 = NA)
Questions	
efforts for community participation	
Community programs	
How do you include and activate people for water governance?	
Nr of meetings, discussions on topic	
Topic represented in local media?	
Topic in schools, etc?	
awareness raising non-ending education?	

Table 3, Indicators and Questions to "IN IMPROVING WATER AND SANITATION MANAGEMENT"	
Normative interpretation: Implies improving the management of all aspects of water and sanitation	
Indicators	
NIF2018	Percentage of developed Irrigated Command Area brought under Water Users Association(WUAs)
New York	Sewer backup complaints received
New York	Sewer backup complaints resolved – Confirmed (on City infrastructure)
New York	Sewer backup complaints resolved – Unconfirmed (not on City infrastructure or unfounded)
New York	Sewer backup resolution time (hours)
New York	Street segments with confirmed sewer backup in the last 12 months (% of total segments)
New York	Street segments with recurring confirmed sewer backup in the last 12 months (% of total segments)
New York	The number of water main breaks
New York	The number of water main breaks per 100 miles of main during the last 12 months.
New York	Average time to restore water to customers after confirming breaks (hours)
New York	Broken and inoperative hydrants (%)
New York	Average time to repair or replace high-priority broken or inoperative hydrants (days)
New York	The total number of clogged catch basin complaints received during the reporting period.
New York	Catch basin backup resolution time (days)
New York	Catch basins surveyed/inspected (%) (cumulative) to identify those in need of cleaning, hooding and/or repair.
New York	Catch basins cleaned.
New York	The total number of catch basins cleaned as part of the Department's regularly scheduled cleaning and maintenance program.
New York	The total number of catch basins cleaned as a result of complaints from the public.
New York	Backlog of catch basin repairs (% of system)

New York	The total number of leak complaints received during the reporting period and the number received for each reporting category.
New York	Leak resolution time (days)
Questions	
What local practices empower the community members water aware practices? Labor tests? self reliance on water source? maintains bunds and channels? Shops that sell water positive products? What are the shared and what are the entitled responsibilities on water management? How do you co-create/share water responsibilities conscious water use based on community values, caretaker responsibility/shared responsibility	

Table 4, Additional Questions on SDG6.b
Questions
Spiritual practices?