



PAVITR

**Potential and Validation
of Sustainable Natural & Advance Technologies
for Water & Wastewater Treatment,
Monitoring and Safe Water Reuse
in India**

Type of action: Research and Innovation action (RIA)

Project duration: 48 months (01.02.2019 – 31.01.2023)

Deliverable D2.8

**1st Training of Local Partners/stakeholders:
ALLOWS tool / Methodology**

Work package: WP2 – Interdisciplinary Approach: Strategic Research & Innovation

Responsible partner: 3-UFZ

Due date of deliverable: 31.07.2021

Actual submission date: 29.07.2021

Nature of Document: Report

Dissemination Level:		
PU	Public	X
CO	Confidential, only for members of the consortium (including the Commission Services)	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	



This project has received funding from the European Union's Horizon 2020 research and innovation programme under **grant agreement No 821410**

Document change history

Version	Date	Author	Description
V1.0	27.07.2021	UFZ	1 st draft
V1.1	29.07.2021	TTZ	Final review

Table of Contents

1. EXECUTIVE SUMMARY	4
2. BACKGROUND AND OBJECTIVES OF THE TRAINING WORKSHOP	5
3. TRAINING WORKSHOP PROCEEDINGS AND SESSION OUTCOME	6
3.1. Organization of the training workshop	6
3.2. Participation.....	7
3.3. Programme proceedings and documentations.....	7
3.3.1. Opening of the training workshop program	8
3.3.2. Training program – Day 1, Session 1 (14 th July, 2021)	9
3.3.3. Training program – Day 1, Session 2 (14 th July, 2021)	11
3.3.4. Training program – Day 1 Wrap up (14 th July, 2021).....	15
3.3.5. Training Program – Day 2, Session 3 (15 th July, 2021)	16
3.3.6. Training program – Day 2, Session 4 (15 th July, 2021)	19
3.3.7. Training program – Day 2, Q&A Session for open discussions (15 th July, 2021).....	21
3.3.8. Training program – Day 2 Wrap up (15 th July, 2021).....	22
3.3.9. General feedback from the participants	22
3.4. General expectations and outcomes	22
4. LESSONS LEARNED FROM THE TRAINING WORKSHOP	23
5. REFERENCES.....	24
LIST OF FIGURES	24
APPENDIX 1: WORKSHOP PROGRAM AND AGENDA	25
APPENDIX 2:.....	28
APPENDIX 3:.....	30

1. Executive Summary

This report summarises the discussions and conclusions from the 1st training workshop of local Indian partners/stakeholders on GIS-based ALLOWS tool/Methodology, which was arranged on 14th and 15th of July, 2021. It was jointly organised by the Helmholtz Center for Environmental Research (UFZ), Germany and the Aligarh Muslim University (AMU), Aligarh, India. To carry out the tasks for one of the work packages of PAVITR project (WP2), a two-day training workshop was held by using virtual meeting platform ‘Zoom’. The program was entitled as “International Training Workshop on GIS based Regional Planning, Water & Wastewater Management in India”.

The main purpose of this training workshop was to train the Indian partners/stakeholders to use the newly developed ALLOWS methodology for planning regional water and wastewater management in order to be able to contribute to its implementation in the selected region near Aligarh, UP, India. Therefore, this training workshop was targeted to attract the most number of Indian participants, who are professionally working in the field of water supply and sanitation and responsible for environment and sewage management in India. Therefore, potential participants from various research institutions, universities, local government bodies (e.g. municipalities, plant operators), NGOs, consulting agencies etc. were invited to attend the training workshop. The interested participants and partners of PAVITR project from several European countries and from India were also invited to attend the training workshop. The workshop was jointly moderated by Dr. Khaja Rahman from the UFZ, Germany and by Prof. Dr. Nadeem Khalil from AMU, Aligarh, India.

The training workshop produced an insight understanding on GIS-based ALLOWS tool/methodology and a roadmap of the future tasks for the Indian stakeholders/decision makers. The workshop served to raise awareness on the topic, current trends, challenges and activities among the workshop participants. Nearly 40 participants from different organisations of India and EU countries took part in the workshop. As shown in the list of the participants in Appendix 2, most of the participants were government representatives, semi-government bodies as well as researchers, non-governmental organization (NGO) representatives, consultants and graduate/post-graduate students from India.

Even though the training workshop program was conducted in online mode with all the presentations and discussions online, the whole format was highly participative. It was structured to facilitate and allow all the participants to enter into discussions after each individual presentations (at least for 10 minutes). There were inputs from the key trainers, guest speakers, workshop organisers and insights from the Indian participants. Feedback from the workshop participants were very positive at the end and they showed great value in working with such innovative and advanced tool for sanitation management planning in India.

UFZ took the lead in drafting this report to provide as an overview of the workshop, background information and objectives, a brief summary of the delivered presentations, open discussions and suggestions/recommendations for the next steps in the near future. A snapshot of each of the presentations are included here in this report and the PDF copies of all the presentations and other support documents will be uploaded in the PAVITR website and will be supplied immediately upon request by any partners/stakeholders¹.

¹ To receive the workshop presentations and other supporting documents, please contact Dr. Khaja Rahman khaja.rahman@ufz.de or Prof. Dr. Nadeem Khalil nkhalil.cv@amu.ac.in

2. Background and Objectives of the Training Workshop

Within the framework of the PAVITR project, the primary objective of the task “Strategy and Decision Making Research Cluster (SDM –RC)” was to develop an innovative Decision Support System (DSS) that will enable the PAVITR consortium, the policy-makers and the stakeholders to identify the most appropriate strategies, measures and cost-effective approaches to reduce economic, social and environmental risks during the execution of the project framework. Decision support systems (DSS) are used to assist governments and communities, helping planners to organize, analyse, edit, and re-evaluate information etc. This DSS spatially simulates potential water/wastewater infrastructures to engage stakeholders and decision makers in a collaborative process for identifying specific needs/requirements and to train them to use the planning tool.

It was proposed to develop a new methodology for the GIS-based ALLOWS tool (van Afferden et al., 2015), that would rely on data not provided by local administrations (such as satellite data). Therefore, the first activity of this task for UFZ was to adapt the ALLOWS tool and its methodology to the specificities of the Indian context through the identification and provision of alternative framework-data sources (e.g. satellite data), review and evaluation of open access data available etc. The tool was then tested in a selected study area of several hundred square kilometres (~ 400 km²) near Aligarh, UP, India. The testing of the new methodology in real conditions was carried out to overcome issues unforeseen during the theorisation of the method and allowed for the preparation of the protocol necessary to the replication and dissemination of ALLOWS tool.

The training for the Indian partners/stakeholders involved in water and sanitation infrastructure planning activities at a technical and economic level to use ALLOWS tool was a part of this preparation. Special efforts were made to integrate students into the project, being for the adaptation and evaluation of specific aspects/components of the tool and to train them to use the tool as a preparation for their professional career.

Therefore, the main objectives of the training workshop were:

- To share the knowledge and experiences and develop the understanding of planning regional water, wastewater and sanitation management in India.
- To provide basic understanding and an overview on the GIS-based ALLOWS Tool and its methodology
- To enable the participating Indian partners/stakeholders to use the newly developed ALLOWS methodology, so that they will be able to contribute to its implementation in any given region in India.

Some specific objectives of the workshop were:

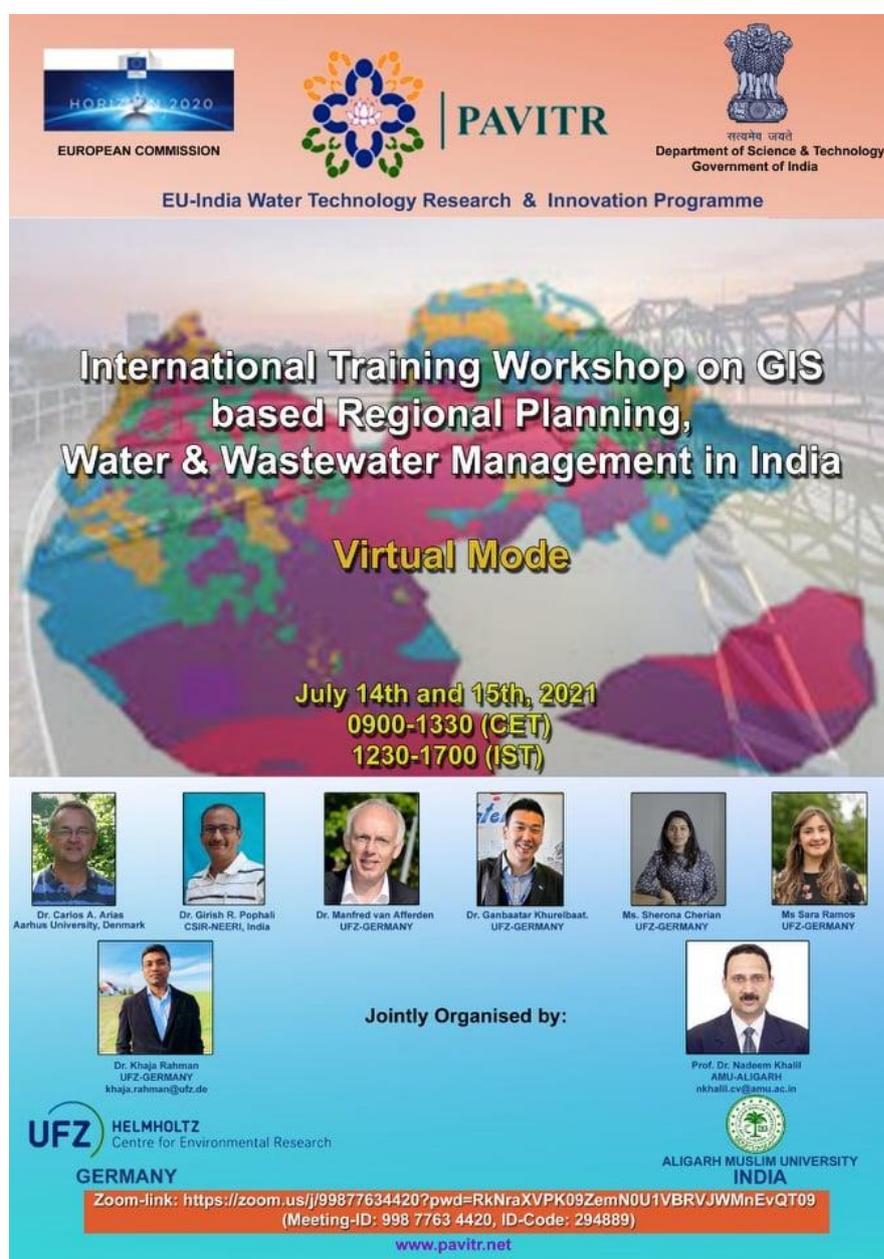
- To bring together international expertise and involve the participants to discuss challenges, share ideas and lessons learned.
- To provide guidelines to the Indian partners/stakeholders about the risks, importance, benefits and principle components of sustainable sanitation management.
- To provide alternatives for collecting data, image classification, assumptions & population projections and increase knowledge on developing various sanitation management scenarios.
- To help the participants to integrate with the potential technical measures, intermediate solutions and economic evaluation to improve the existing sanitation conditions in India.
- To enhance and strengthening the relationship between the institutions of India and the EU.

3. Training Workshop Proceedings and Session Outcome

The following section briefly describes the whole training workshop program organizations and structure, participants, program proceedings, presentation themes, raised issues and outcome of each session.

3.1. Organization of the training workshop

The training workshop was jointly organized by the Helmholtz Centre for Environmental Research (UFZ), Germany and Aligarh Muslim University (AMU), India, in cooperation with other EU and Indian partners. The workshop was jointly moderated by Dr. Khaja Rahman (UFZ) and Prof. Dr. Nadeem Khalil (AMU). Fig. 1 shows the invitation of the training program which was distributed among the potential Indian partners and stakeholders, together with the full-program agenda.



The invitation poster features logos for the European Commission (H2020), PAVITR, and the Government of India (Department of Science & Technology). The main title is "International Training Workshop on GIS based Regional Planning, Water & Wastewater Management in India" in "Virtual Mode". The dates are "July 14th and 15th, 2021" with times "0900-1330 (CET)" and "1230-1700 (IST)".

Participants listed include:

- Dr. Carlos A. Arias (Aarhus University, Denmark)
- Dr. Girish R. Pophali (CSIR-NEERI, India)
- Dr. Manfred van Afferden (UFZ-GERMANY)
- Dr. Ganbaatar Khurelbaat (UFZ-GERMANY)
- Ms. Sherona Cherian (UFZ-GERMANY)
- Ms. Sara Ramos (UFZ-GERMANY)
- Dr. Khaja Rahman (UFZ-GERMANY)
- Prof. Dr. Nadeem Khalil (AMU-ALIGARH)

Organized by UFZ HELMHOLTZ Centre for Environmental Research, GERMANY and ALIGARH MUSLIM UNIVERSITY INDIA.

Zoom-link: <https://zoom.us/j/99877634420?pwd=RkNraXVPK09ZemN0U1VBRVJWmEvQT09>
 (Meeting-ID: 998 7763 4420, ID-Code: 294889)
www.pavitr.net

Fig. 1: Invitation format of program, which was distributed among the potential Indian partners and stakeholders two weeks before the training workshop.

Together with the organizers, the members of the training team were Prof. Dr. Nadeem Khalil (AMU), Dr. Khaja Rahman (UFZ), Dr. Ganbaatar Khurelbaatar (UFZ), Ms. Sara Ramos (UFZ and TUD) and Ms. Sherona Cherian (UFZ and TUD). Two guest lecturers were Carlos A. Arias, Ph.D. (Aarhus University, Denmark) and Dr. Girish R. Pophali (CSIR-NEERI, India). Unfortunately due to sickness issue, Dr. Girish Pophali could not join but he was very kind and willingly sent his presentation slides to the workshop organizers. Afterwards it was decided that Prof. Dr. Nadeem Khalil (AMU) will present it instead. The whole program agenda of the training workshop is attached at the end of the report in **Appendix 1**.

3.2. Participation

The training workshop program was open for all PAVITR EU and Indian partners. The target participants of the workshop were mainly Indian national, regional partners/stakeholders, water and wastewater management practitioners, professionals, experts, members of regional and local public agencies, NGOs that are working on sanitation management in India, staff members of the research institutes, relevant departments of different universities, local municipal administration staff members, district office staff etc. Since this workshop was jointly organized in close coordination with AMU, India, therefore a large number of graduate/post-graduate students, research fellows (JRFs and SRFs), and concerned faculty members of AMU also attended and actively participated. The participants were expected to have a reasonable knowledge and expertise in water and wastewater management and related infrastructure. All the participants from Indian side were invited by the workshop organiser from AMU, India and the PAVITR EU-participants were invited by the UFZ, Germany via E-mail correspondence.

It was hoped that on returning to their business after the training workshop, the Indian participants/stakeholders can potentially influence the policy formulation and campaign on raising awareness among the local community and common people. They could therefore potentially influence essential reforms in the sanitation management and risk mitigation sector in India. For a detailed list of the workshop participants/attendees, please find **Appendix 2** at the end of this report.

3.3. Programme proceedings and documentations

The training workshop was a two-day program, comprising four (4) sessions. There were 7 presentations on day-1 and 5 presentations on day-2 from both form International and Indian experts. The proceedings were pre-planned and scheduled on the basis of 2 main aspects:

- a) To present and discuss interactively among the workshop participants on GIS-based ALLOWS tool and regional planning for sustainable sanitation management;
- b) To initiate open discussions (Q&A session) to exchange and share the experiences with the local stakeholders and decision makers from India.

All the presentations and interactive discussions during the training workshop were designed to achieve maximum output on understanding the basics of ALLOWS tool and its step-by-step implementation under Indian context. Details of the presentation themes delivered by the trainers/presenters are given in the following sections of this report.

3.3.1. Opening of the training workshop program

The training workshop program was opened by Prof. Dr. Nadeem Khalil (AMU) from the Indian side and Dr. Manfred van Afferden (UFZ) from the EU side. At the beginning, Prof. Dr. Nadeem Khalil welcomed all the workshop participants, trainers and presenters, invited guests, national and international experts, representatives of the national and international partner companies, water/wastewater experts and Professionals, academia, researchers and local community members joining from Aligarh and other parts of UP, India. In his opening address, he clearly expressed the special interest of Indian government and his university administration and the necessity to organize such training in the specific field of water/wastewater management and regional infrastructure planning. He then briefly elaborated the PAVITR project, objectives of different work packages of the project and involved PAVITR technologies that are being established. He then requested all the participants to voluntarily write down their full-name, affiliation and contact E-mail address in the chat-box, in order to create a list of the participants for future correspondences. Finally, he was wishing a lot of success for the workshop and looking forward to the program outcome.

It was followed by another welcoming address from Dr. Manfred van Afferden (UFZ). He introduced the whole training team, briefly described the objectives of the training workshop, probable outcomes etc. Finally, he thanked all the participants and wished his best to make the workshop a success for the joint EU/India PAVITR project.

3.3.2. Training program – Day 1, Session 1 (14th July, 2021)

The first day of the workshop covered the basic knowledge and understanding on the GIS-based planning tool. It started with the presentation on PAVITR regional planning and introduction to the selected study area in India, which was presented by Dr. Khaja Rahman (UFZ). In this presentation, the fundamental need and importance of regional planning and potential challenges that the decision makers and stakeholders are facing when planning water and wastewater management in India were thoroughly discussed. A brief overview on the ALLOWS methodology and different scenario development by using satellite data were also covered. Afterwards, the reasons behind the study area selection, its location, topography and overview of the whole study area near Aligarh (ca. 400 km²) were precisely presented (Fig. 2).

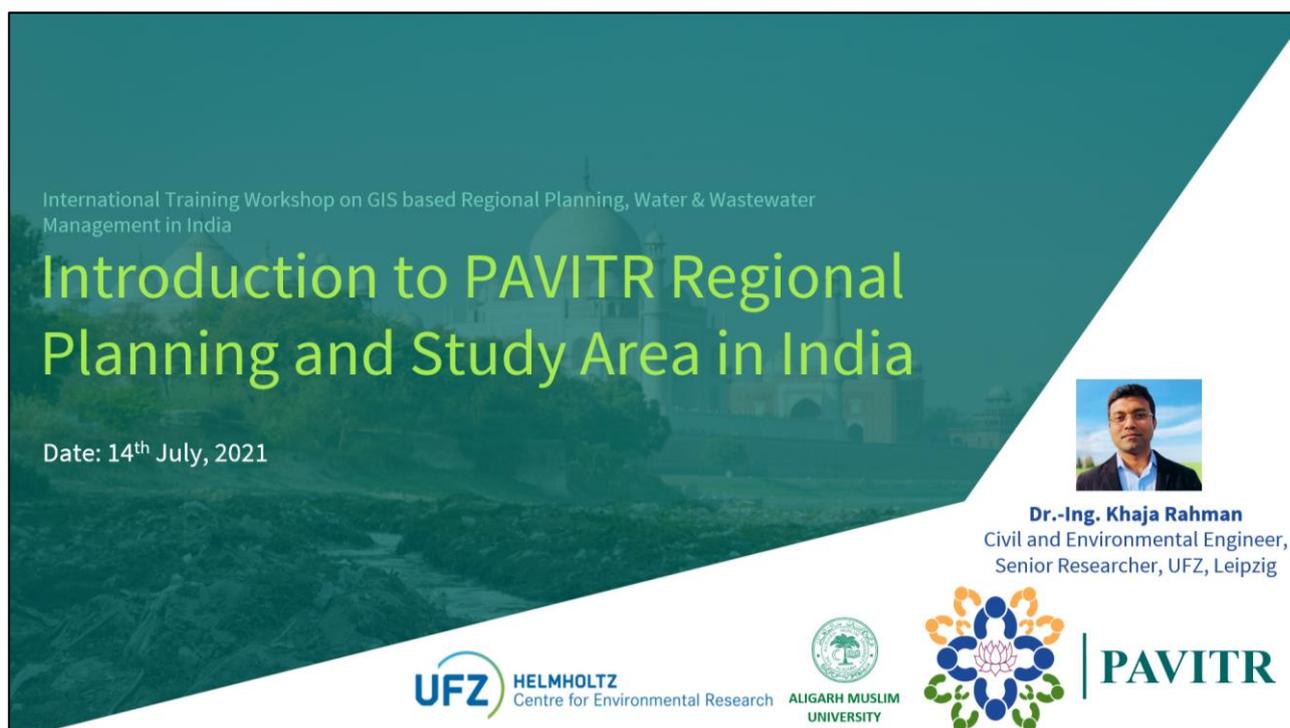


Fig. 2: Dr. Khaja Rahman (UFZ) was presenting on the introduction to PAVITR regional planning and selection of study area in India.

This was followed by the presentation of Ms. Sherona Cherian (UFZ), describing the current conditions of water and wastewater infrastructure and wastewater generation rate within the selected study area in India (Fig. 3). It was shown how the current water/wastewater practices, for example, open defecation, inadequate sanitation, apparently no method for proper sewage disposal, septic tank outlet discharges to drains, non-existence of wastewater treatment plant etc., influence potential risks on health, environment and economy.

Current water supply situation, per capita water consumption and wastewater generation rate, wastewater flowing through open drains and collection into nearby ponds were also well documented with photos collected from the study area and open sources.

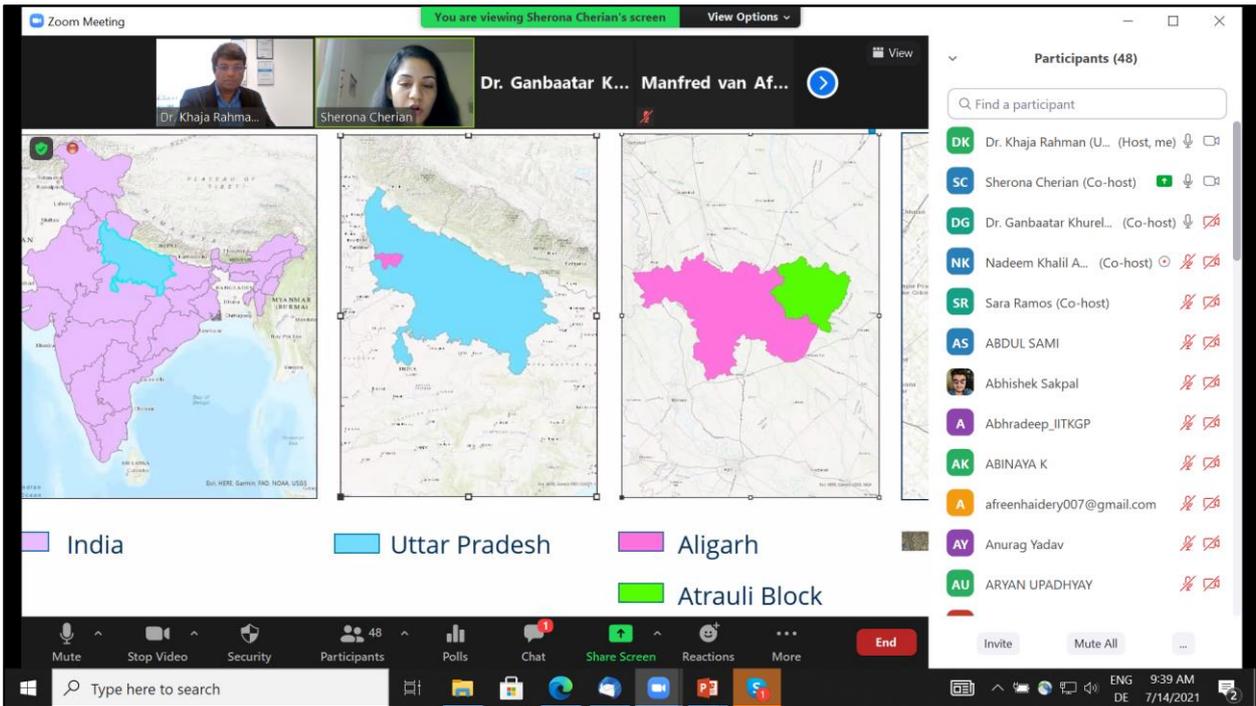


Fig. 3: Ms. Sherona Cheria presented the current conditions of water/wastewater infrastructure within the selected study area near Aligarh, Atrauli Block in India.

Afterwards, Dr. Ganbaatar Khurelbaatar (UFZ) delivered a brief introduction to the GIS-based ALLOWS tool methodology, its necessity and applications of ALLOWS (Fig. 4). Case studies and application of ALLOWS in Jordan, Palestine, China, Oman and India, where ALLOWS approach for different scenarios, cost assessment and comparison of costs results were carried out are also presented. There was a 30 min break for coffee/lunch at this point of the workshop and after the break, the session 2 of the program started and continued till the end of day 1.



Fig. 4: Dr. Khurelbaatar presented a brief introduction to the GIS-based ALLOWS tool on day 1.

3.3.3. Training program – Day 1, Session 2 (14th July, 2021)

The session 2 started with the training on learning how to process data and classify the images, in case of lack of available data. This was presented by Ms. Sara Ramos (UFZ) and she clearly demonstrated the data extraction methodology and initial input of the study area (satellite image) by using ArcGIS Pro, an image classification wizard. Main parameters of an image classification, classification scheme, training samples of ponds, buildings, trees, shadows, roads, agricultural fields, river, artificial canal, manual re-classification and the final steps of conversion into features (lines, polygons), population estimation and population projection for a design period of 60 years were discussed step-by-steps in this presentation (Fig. 5). The key feature was that the information extracted from satellite imagery allows the creation of thematic maps required for development of wastewater management scenarios for regional planning.

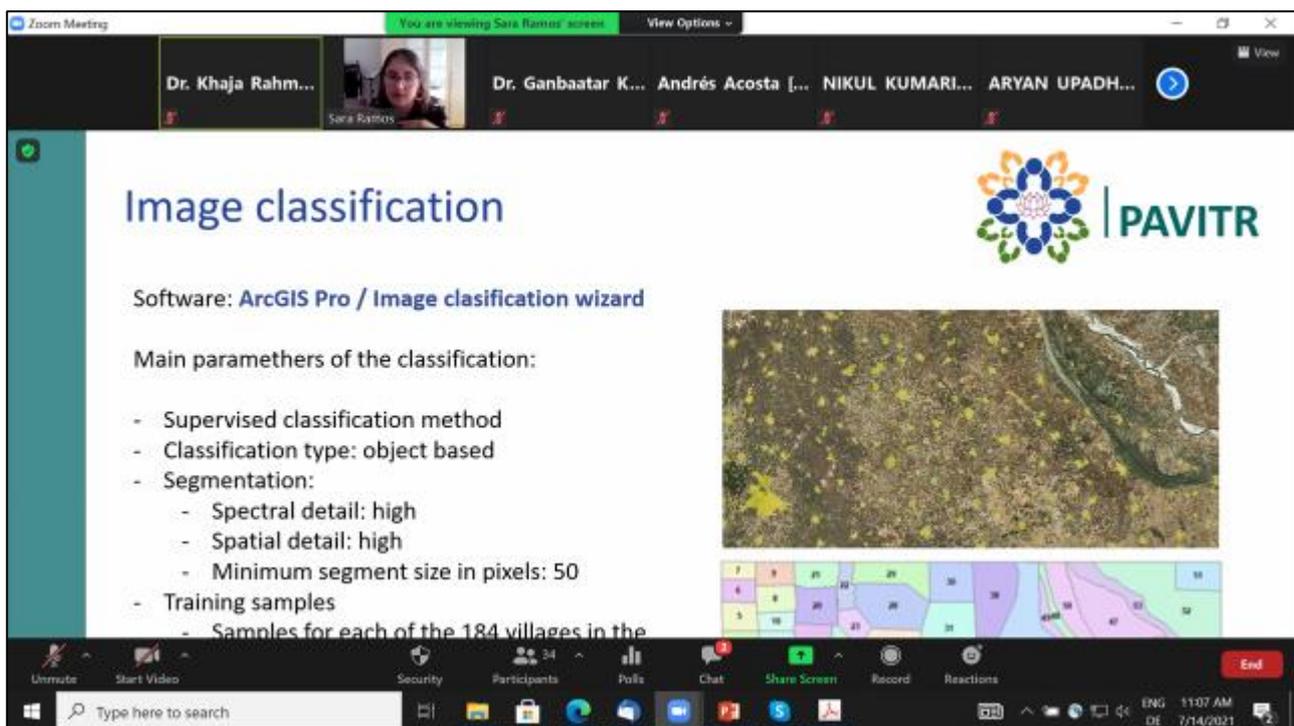


Fig. 5: Ms. Sara Ramos (UFZ) demonstrated the data extraction methodology and initial input of the study area (satellite image) by using ArcGIS Pro in session 2.

This was followed by presenting on how to analyse the risks and thereby prepare prioritization mapping, based on the results of that risk analysis. Typical risks associated with poor sanitation, identifying the risk factors, analysis of risks by using multi-criteria decision analysis (MCDA) and preparing the risk mapping were presented and thoroughly discussed in this presentation (Fig. 6).

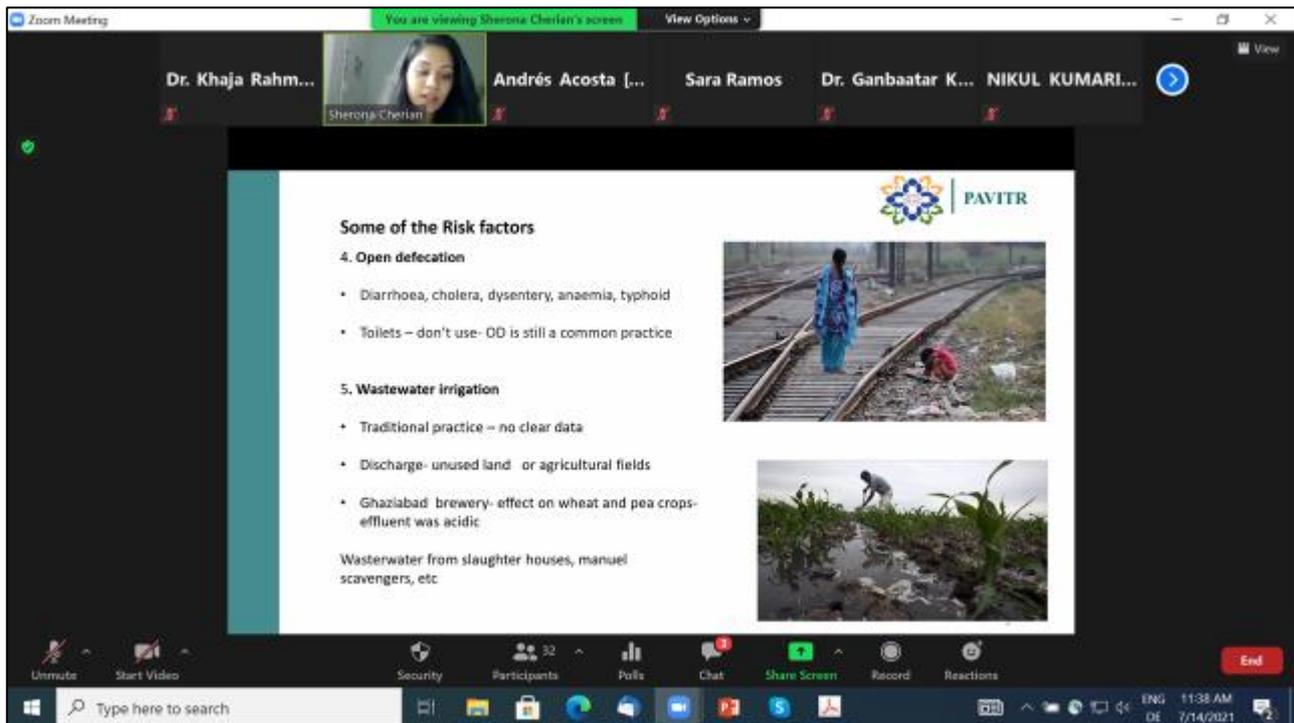


Fig. 6: Ms. Sherona Cherian (UFZ) presented on the potential risk factors and thereby how to prepare the risk and prioritization mapping for the study area using GIS.

Based on the risk mapping, how the intensity of risk in each village were calculated and categorized the villages in different colour ('Green' as low risk villages to 'Red' as very high risk villages) were also shown. Afterwards the prioritization mapping preparation was demonstrated in order to identify the most critical villages that are needed to get the highest priority for immediate wastewater management planning.

The next theme or item of session 2 was dedicated to the GIS-based Sewer Network Design. This was jointly presented by Dr. Ganbaatar Khurelbaatar (UFZ) and Ms. Sara Ramos (UFZ). Basic input data and data processing (buildings, roads, Digital Elevation Model), hydrologic analysis, sewer network design methodology and optimization were demonstrated in Part 1 (Fig. 7a) and GIS-based sewer network design (Trunk lines) within the villages of the selected area were shown in Part 2 (Fig. 7b).

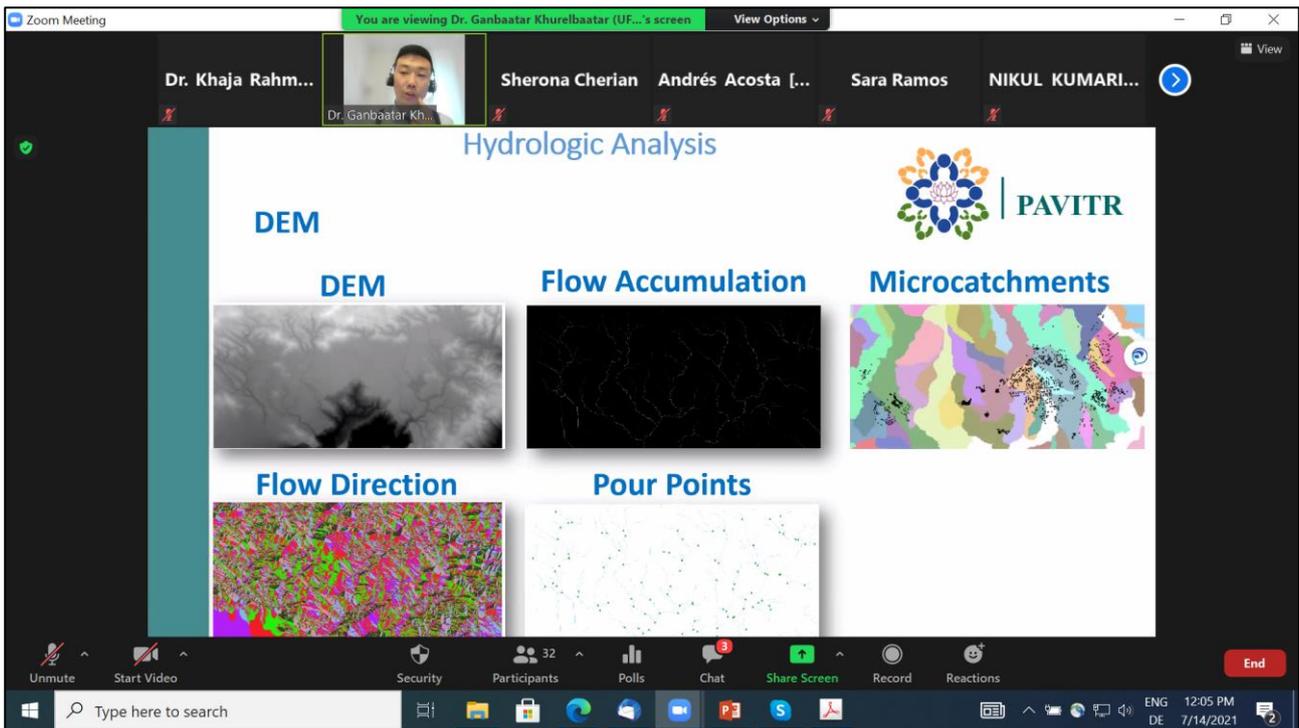


Fig. 7a: Dr. Ganbaatar Khurelbaatar (UFZ) demonstrated the data processing and hydrologic analysis for sewer network design and optimization.

The need and requirements for sewer network design between the villages, for e.g. the length of the trunk lines, layout of the sewer network, numbers of pumping systems, number of WWTPs etc., were clearly demonstrated by taking different scenarios (centralised, clustered) into considerations in Part 2 (Fig. 7b).

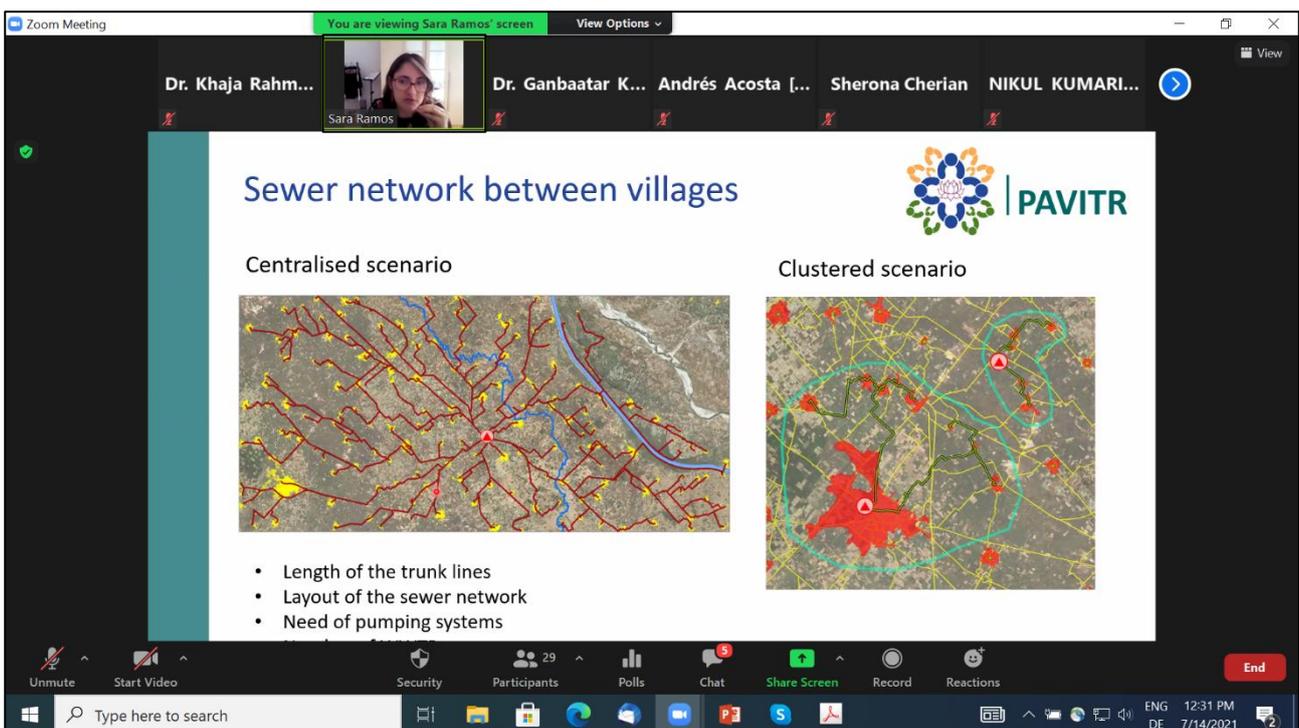


Fig. 7b: Ms. Sara Ramos (UFZ) demonstrated the GIS-based sewer network design (trunk lines) between the villages of the selected study area by using ArcGIS Pro software.

The final presentation of Day 1 Session 2 was on ALLOWS cost assessment, i.e. the economic analysis of the scenarios. This was also presented by Dr. Ganbaatar Khurelbaatar (UFZ). In this presentation, he showed the methodology of ALLOWS cost assessment, dynamic cost comparison and Net Present Value (NPV) calculations with simple examples, comparing investment cost and long term analysis, conversion of the future cost in present value etc. (Fig. 8)

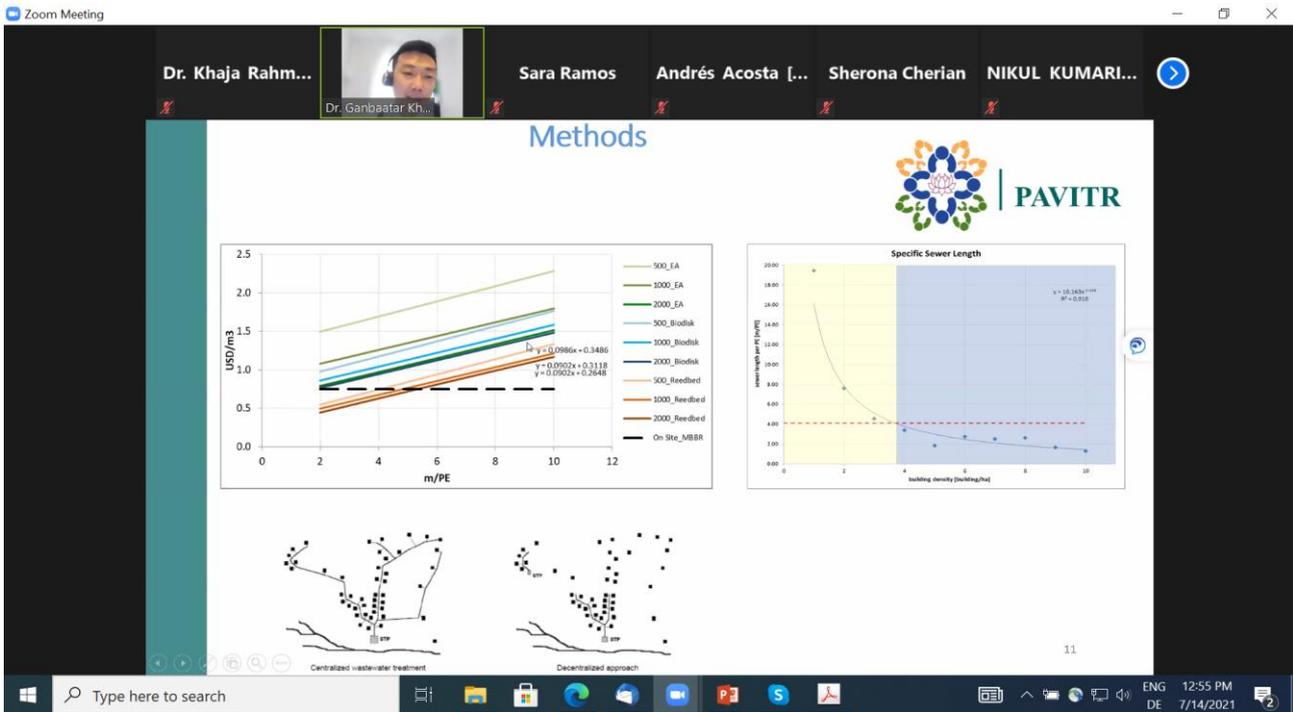


Fig. 8: Dr. Ganbaatar Khurelbaatar showed the ALLOWS cost assessment methodology and dynamic cost comparison with calculated Net Present Value.

To evaluate the costs of scenarios for water and wastewater solutions, PAVITR aims to adapt exiting cost functions for water supply and sanitation technologies to Indian conditions as well as to develop new cost functions for novel PAVITR technologies (prepared by BOKU, Austria). The updated and new cost functions developed will be finally linked with the ALLOWS tool by the UFZ and used for evaluation of the water and sanitation scenarios.

3.3.4. Training program – Day 1 Wrap up (14th July, 2021)

At the end of session 2, a wrap up of highlights of day 1 incorporating the lessons learnt from the covered topics were presented and discussed. The training participants were expected to learn on the following items or themes:

- EU/India PAVITR project and the objectives of PAVITR regional planning.
- Need and importance of planning regional water/wastewater management for India.
- Selection process of the study area near Aligarh, India and current condition of water/wastewater infrastructure within the study area.
- Introduction to the ALLOWS tool and understanding the case studies from Jordan and Oman.
- Data processing and methodology for image classification (e.g. satellite data).
- Identifying the risk factors that can be mapped and prepare prioritization mapping for the study area.
- Minimum data needed for sewer network design and trunk lines and how to optimize them.
- Using of gravity flow to avoid or reduce the number of pumping stations and locating the wastewater treatment plant (WWTP) at the lowest point or any such desired location.
- ALLOWS cost assessment, economic analysis, dynamic cost calculation as well as cost comparison of the scenarios.
- High O&M cost for a longer period of time is playing a big role for a high overall cost, even though the investment cost is lower.

Before closing the session, a group photo of the participants joined in day 1 proceedings were taken and that can be found at the end of this report in **Appendix 3**.

3.3.5. Training Program – Day 2, Session 3 (15th July, 2021)

On day 2, the first session was dedicated to the state-of-the-art technologies for centralized and decentralized wastewater management, based on the experiences achieved from Germany, Jordan, India and PAVITR project. The first presentation of the session was delivered by Dr. Khaja Rahman (UFZ), which was entitled as “State-of-the-art technologies for decentralized wastewater management and reuse” (Fig. 9).



Fig. 9: Dr. Khaja Rahman (UFZ) presented on the state-of-the-art technologies for decentralized wastewater management and reuse potential that have been experienced in Germany and Jordan.

This presentation covered the items like, the necessity of wastewater management and its challenges in rural areas, basic understanding of different wastewater management scenarios (from centralized to different variant of decentralized management), household treatment unit, tanker solution, various nature-based systems and their operation at various demonstration sites in Leipzig, Germany, problems in operation of such small wastewater treatment systems, treated wastewater reuse options and a capacity development program case study for the primary-school level children in Jordan, demonstrating how the children learn to construct simple wastewater treatment technologies (sand filter, constructed wetland) for treating artificial wastewater they simply prepare and how to reuse the treated wastewater for gardening/agricultural purposes.

This was followed by the presentation of our guest lecturer Dr. Girish R. Pophali (CSIRNEERI, India), which was entitled as “Decentralised & Centralised Sewage Management: an Indian experience”. But unfortunately due to sudden illness of Dr. Girish, the presentation was delivered by Prof. Dr. Nadeem Khalil (AMU). This presentation (Fig. 10) covered different governing regulations for sewage and industrial effluent in India, various conventional and hybrid treatment systems for domestic sewage management in Nagpur, India, their treatment performance and effectiveness under Indian context, ongoing PAVITR technologies and their expected performances as compared to conventional systems, advantages of natural treatment systems, sludge handling and management etc.

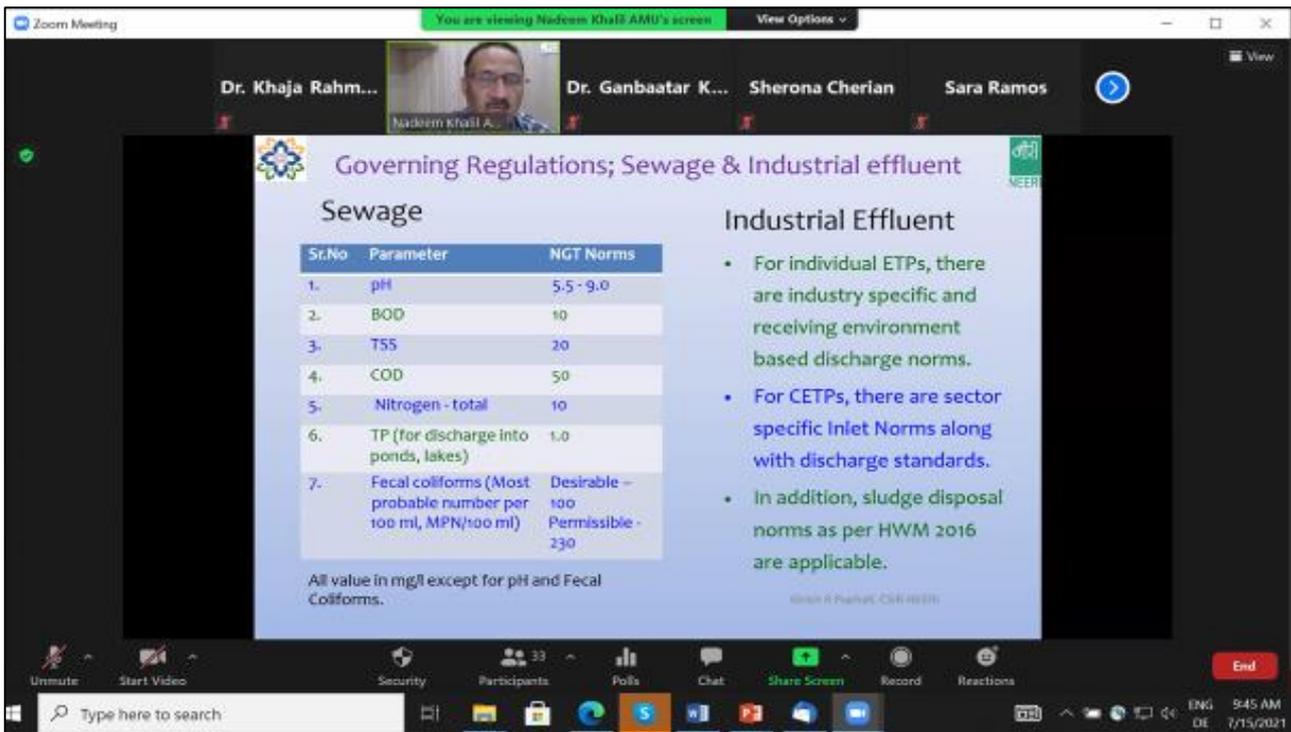


Fig. 10: Prof. Dr. Nadeem Khalil (AMU) presented on decentralised & centralised sewage management that have been experienced in India (in absence of Dr. Girish R. Pophali, CSIRNEERI)

The last presentation of this technology oriented session was delivered by Carlos A. Arias, Ph.D. (Aarhus University, Denmark), highlighting the resource recovery potential of nature-based systems (Fig. 11).

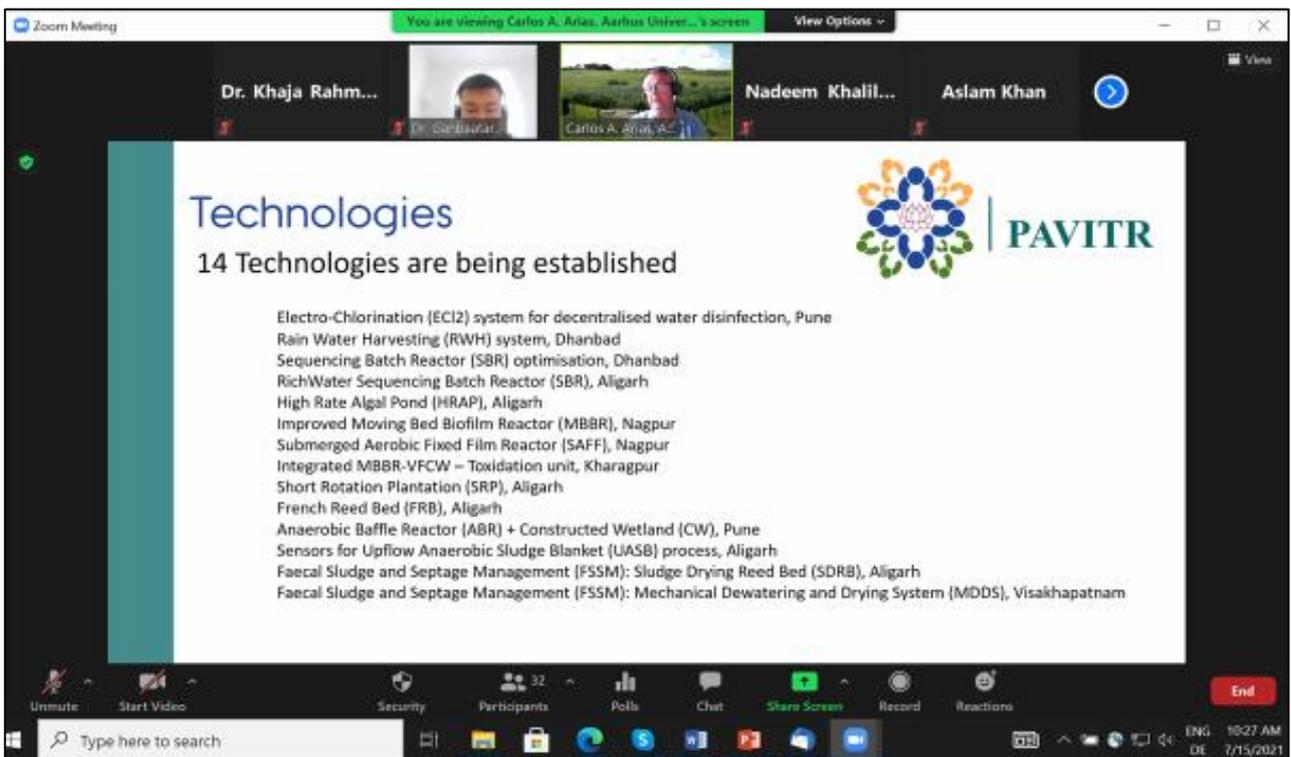


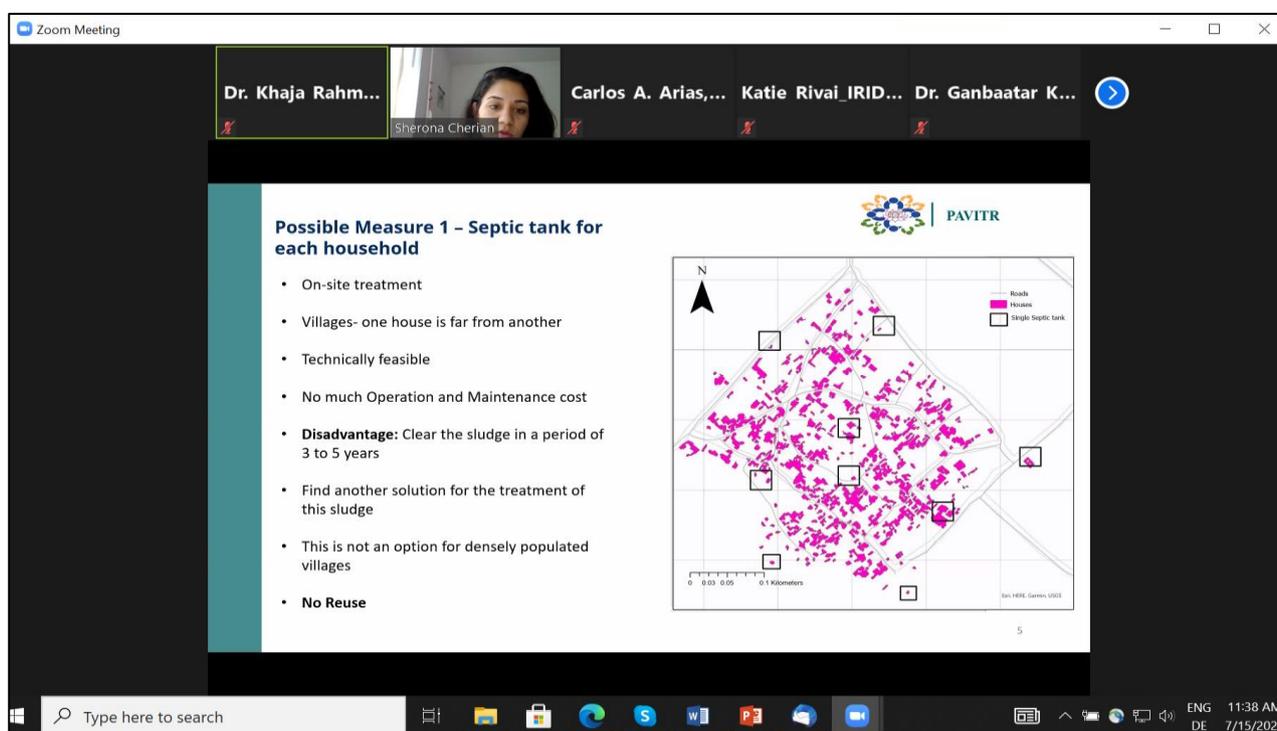
Fig. 11: Carlos A. Arias, Ph.D. (Aarhus University, Denmark) presented on resource recovery potential of nature-based systems and PAVITR technologies that are being established.

He started with the global challenges due to poor water and sanitation conditions, and then he elaborately discussed on biomass production, biomass application and resource recovery potential of using nature-based solutions, PAVITR technologies that are being established, potential removal and/or recovery of emerging contaminants (e.g. micro-pollutants, pharmaceutical compounds), micro-plastics, heavy metals and metalloids from polluted water using nature-based systems etc.

3.3.6. Training program – Day 2, Session 4 (15th July, 2021)

The second session of day 2 (overall session number 4) was composed of two more presentations on potential technical measures that are needed to be implemented as intermediate solutions and the second one was on the development & evaluation of different sanitation management scenarios for the selected area in India. Afterwards, a Q&A session with open discussions covering the findings and challenges of the training workshop participants was carried out, and it was followed by a wrap up session with take home messages and next steps.

The first presentation on potential technical measures as intermediate solutions for the study area and corresponding economic evaluation for those technical measures were delivered by Ms. Sherona Cherian (UFZ). Some alternative solutions (e.g. septic tank for each households, septic tank + sewer network, complete sewer network), together with their cost estimations and cost comparisons, risk re-evaluation after potential implementation of these technical measures etc. were demonstrated and discussed with the participants (Fig. 12).



Possible Measure 1 – Septic tank for each household

- On-site treatment
- Villages- one house is far from another
- Technically feasible
- No much Operation and Maintenance cost
- **Disadvantage:** Clear the sludge in a period of 3 to 5 years
- Find another solution for the treatment of this sludge
- This is not an option for densely populated villages
- **No Reuse**

Fig. 12: Ms. Sherona Cherian (UFZ) presented on possible technical measures that are needed to be implemented for the improvement of existing conditions within the selected area near Aligarh, India.

This was followed by presenting on the development and evaluation of different sanitation management scenarios, which was delivered by Ms. Sara Ramos (Fig. 13). Total project cost comparison when considering different scenarios (centralized, decentralized, clustered) and the systematic way to define the clusters were also discussed. She clearly demonstrated that the used methodology can support decision making processes on sanitation projects at a regional scale and in rural areas worldwide.

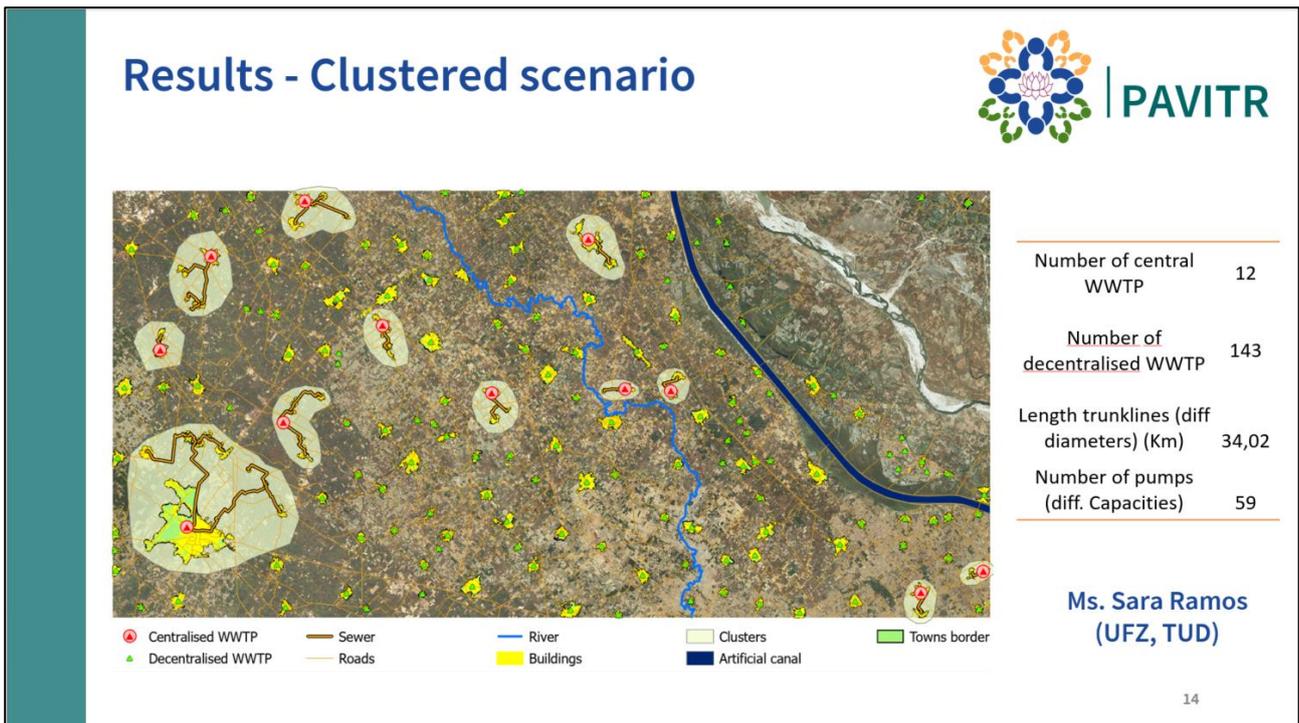


Fig. 13: Ms. Sara Ramos (UFZ) presented on evaluating different sanitation management scenarios and cost comparison of the developed scenarios for the selected area near Aligarh, India.

3.3.7. Training program – Day 2, Q&A Session for open discussions (15th July, 2021)

All the questions, comments, observations and feedback raised (directly and via chat-box) by the training workshop participants and the answers given by the trainers/organisers were discussed in this open discussion session. The aim of this session was to share their experiences, to learn from each other and to discuss about how the wastewater management practices should be improved to make it more sustainable under Indian context.

For this, the participant partners/stakeholders from key institutions and organizations were asked to address some questionnaire and to answer them with the best of their knowledge and experiences. Some of the questions were pre-selected by the workshop trainers, based on their experiences and lessons learned from previous project in India and also from other countries/regions around the world. The pre-selected questions under Indian context were as the followings:

- What are the current status and trends on wastewater production, treatment and reuse for agriculture or other purposes in local and national level?
- Is the water supply unlimited or limited for daily use, specifically in the rural areas?
- Is there already a policy framework, strategy on water consumption, wastewater treatment and safe reuse of treated wastewater in the country or not?
- Who are the key organizations or local bodies that are responsible and working on safe water supply and wastewater management practices in their respective area/locality?
- Are there any assessment of knowledge, skills and competences or any capacity development program, awareness campaign on the basic sanitation management and safe reuse of treated wastewater in India?
- What about the affordability of the common people? Are the villagers at that point to pay for the treatment of the generated wastewater? If not, then who will be paying for this?
- What to do with the open drains and existing ponds? How to manage raw wastewater collection, transport, treatment and reuse for the improvement of the existing conditions?
- What to do to convince the villagers to use the toilets? Any measures that have been taken yet?
- What should be the approaches as a decision maker/stakeholder in order to solve these issues raised in this training workshop and what are the most challenges/hurdles they face in India?
- What is your proposal as an Indian stakeholder to make your development sustainable when you are planning water/wastewater management in India?

The raised questions via chat-box were answered immediately by the organizers during the training workshop and also after the program. It was a very interesting and fruitful discussion session among the participants and training organizers in general.

Through such Q&A session, it was possible to promote cross-stakeholder engagements, find ways to promote better understanding of the current problems for the decision makers, promote localisation of the rural community, connect local bodies to stimulate knowledge sharing and capacity development program which is appropriate to the local context.

3.3.8. Training program – Day 2 Wrap up (15th July, 2021)

The purpose of the wrap-up was to jointly develop ideas and proposals for a potential second training workshop on GIS-based ALLOWS tool. It may not be possible to organise a second training workshop in India due to prolonged travel restrictions and pandemic worldwide. Therefore, after discussing with the participants, several proposals were made for the accomplishment of the second training or any such alternatives. The UFZ can prepare a “Training Concept” or an “Operation Manual” document on ALLOWS tool for the Indian partners/stakeholders, together with the results achieved from Indian case study. The UFZ can also prepare a “GIS-based Training Course Materials” (2-days intensive), which can be taught at the university level in India. The UFZ can also be a part of other PAVITR workshops organised by other partners during the total project time and invite the Indian partners/stakeholders, as like it was in this 1st training workshop. After completion of the potential 2nd training program on the updated ALLOWS tool, a “Certificate” can also be provided for the participants next time. However, it will be decided after discussing with the other PAVITR partners, who are intended to organize such interactive workshops in the near future.

After the wrap up session, Dr. Khaja Rahman (UFZ) and Prof. DR. Nadeem Khalil (AMU) jointly closed the training workshop program by thanking to all the participants and the training team for their contributions to the workshop sessions, and conveyed special thanks to the invited guests for participating in the workshop.

3.3.9. General feedback from the participants

During the training workshop proceedings and immediately after the workshop, the following feedback were received from the participants and collected by the organizers (UFZ and AMU):

- It was a good experience and good lessons learned.
- The training workshop was very fruitful and praiseworthy.
- They found the workshop very interesting and informative.

In particular, the participants appreciated the joint initiative of the training workshop organizers, providing a comprehensive insight into the range of aspects that need to be considered in the development and implementation of sustainable sanitation management policies and practices.

3.4. General expectations and outcomes

The workshop, hosted by the UFZ and AMU brought together nearly 40 on a daily basis (average in 2 days) water and wastewater specialists, consultants, academics and professionals (see Appendix 2) from a range of different governmental agencies, NGOs, research institutes in India and EU countries. It was a unique effort by the workshop organizers towards arranging the virtual training program due to prolonged pandemic situation. The feedback of the participants from the training workshop was well-received and appreciated by the organizers.

The main objectives and expectations of the training workshops were fulfilled as the organizers raised the awareness among the participants on sustainable regional planning for water and wastewater management in India, demonstrated potential risks mitigation and benefits for public health, environment, society and the economy, provided a platform to exchange experiences and establish networks by creating a community for continuing exchange on recent implementation strategies of ALLOWS tool, facilitated the dissemination of available guidelines to the relevant organizations and stakeholders from India.

4. Lessons learned from the training workshop

Key findings and lessons learned from the 2-days training workshop are summarized as follows:

- In order to implement the 2006 WHO Guidelines, it may need to consider updating national policies and/or standards to accommodate the wastewater treatment and reuse guidelines.
- Identifying potential risk factors associated with the poor sanitation systems and analysing the risk criteria based on multi-criteria analysis to classify the villages are urgently needed.
- Need to prepare risk and prioritization maps by using GIS for the improvement of the current conditions, find intermediate solutions for risk avoidance and associated costs for the alternative solutions that can be adapted to the local conditions
- ALLOWS tool needs to be further developed and implemented in a regional scale, defining a methodology and provide recommendations to the local stakeholders for planning wastewater management at a regional scale.
- In case of lack of available data, the extraction of data on infrastructure, topography etc. from satellite images & open-access data are the alternative method and analysis of local conditions (micro-catchments, location of villages etc.) for wastewater transport using GIS-based tool should be carried out.
- The information extracted from satellite imagery allows the creation of thematic maps required for development of wastewater management scenarios for regional planning and can be used for the estimation of population when required.
- The satellite images are used to develop assumptions and indicators on water supply and sanitation situation, such as, water use per capita, connection degree and demographic development etc. and finally, the extracted data and the developed assumptions are used for the development of the wastewater management scenarios.
- Sewer network analysis allowed to determine where to locate central WWTP, and which would be the layout of the sewer lines.
- Local experts and decision makers would be ideal if they can generate the results for the donors, investors, funding agencies.
- Selecting sustainable and affordable solutions for sanitation management planning and suitable technologies
- In order to achieve in-depth support from the villagers and local community, specific capacity development program on safe use of water and wastewater for the local experts and stakeholders must be addressed more frequently at national, regional and local village levels.

5. References

AMU (2021): personal communication

AU and NEERI (2021): personal communication

TTZ (2020): personal communication

van Afferden, M., Cardona, J.A., Lee, M.Y., Subah, A., Müller, R.A., (2015). A New Approach to Implementing Decentralized Wastewater Treatment Concepts. *Water Science and Technology*, 72(11), 1923-30.

List of Figures

Fig. 1: shows the invitation format of program, which was distributed among the potential Indian partners and stakeholders before the training workshop.

Fig. 2: Dr. Khaja Rahman (UFZ) was presenting on the introduction to PAVITR regional planning and selection of study area in India.

Fig. 3: Ms. Sherona Cherian was presenting the current conditions of water/wastewater infrastructure within the selected study area near Aligarh, Atrauli Block in India.

Fig. 4: Dr. Khurelbaatar presented on a brief introduction to the GID-based ALLOWS tool on day 1.

Fig. 5: Ms. Sara Ramos (UFZ) demonstrated the data extraction methodology and initial input of the study area (satellite image) by using ArcGIS Pro in session 2.

Fig. 6: Ms. Sherona Cherian (UFZ) presented on the potential risk factors and thereby how to prepare the risk and prioritization mapping for the study area using GIS.

Fig. 7a: Dr. Ganbaatar Khurelbaatar (UFZ) demonstrated the data processing and hydrologic analysis for sewer network design and optimization.

Fig. 7b: Ms. Sara Ramos demonstrated the GIS-based sewer network design (Trunk lines) between the villages of the selected study area by using ArcGIS Pro software.

Fig. 8: Dr. Ganbaatar Khurelbaatar showed the ALLOWS cost assessment methodology and dynamic cost comparison with calculated Net Present Value.

Fig. 9: Dr. Khaja Rahman (UFZ) presented on the state-of-the-art technologies for decentralized wastewater management and reuse potential that have been experienced in Germany.

Fig. 10: Prof. Dr. Nadeem Khalil (AMU) presented on decentralized & centralized sewage management that have been experienced in India (in absence of Dr. Girish R. Pophali, CSIRNEERI)

Fig. 11: Dr. Carlos A. Arias, Ph.D. (Aarhus University, Denmark) presented on resource recovery potential of nature-based systems and PAVITR technologies that are being established.

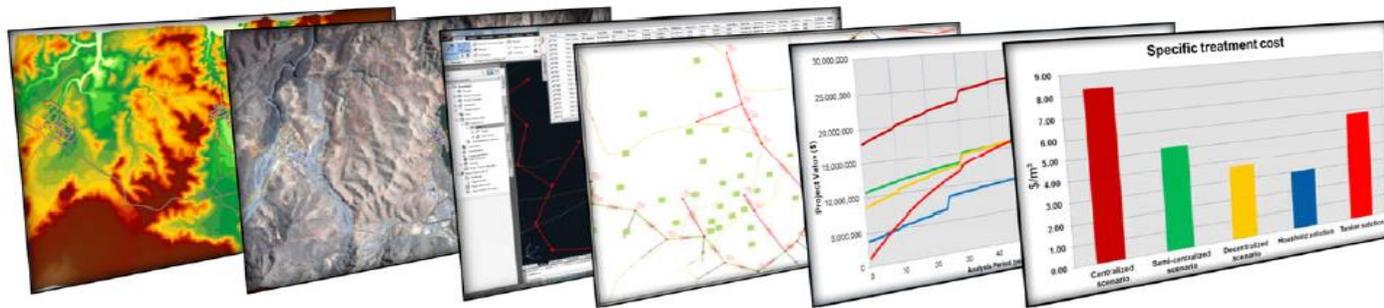
Fig. 12: Ms. Sherona Cherian (UFZ) presented on possible technical measures that are needed to be implemented for the improvement of existing conditions within the selected area near Aligarh, India.

Fig. 13: Ms. Sara Ramos (UFZ) presented on evaluating different sanitation management scenarios and cost comparison of the developed scenarios for the selected area near Aligarh, India.

Appendix 1: Workshop program and agenda

International Training Workshop on GIS based Regional Planning, Water & Wastewater Management in India

Date: July 14th and 15th, 2021 (Wednesday and Thursday)



Organised and supported by:



EU-India Water Technology & Management Project



European Commission



Department of Science and Technology, Government of India

Objectives: The Indian partners/stakeholders will be trained on GIS-based regional planning methodology for water & wastewater management in order to be able to contribute to its implementation in India.

Target Audience: Indian stakeholders in water & wastewater sector, Engineers, Wastewater professionals, Treatment Plant operators, Graduate & Post-graduate students etc.

Training Workshop Agenda (Day 1)

Day 1 (14.07.2021, Wednesday)

Time (CET)	Time (IST)	Session	Session Theme	Presenter (Institute name)
9:00 am	12:30 pm	1	Welcome speech: PAVITR project & Training Workshop Introduction to PAVITR Regional Planning & Study Area	Prof. Dr. Nadeem Khalil (AMU) & Dr. Manfred van Afferden (UFZ), Dr. Khaja Rahman (UFZ)
9:30 am	1:00 pm	1	Current Conditions on Water and Wastewater Infrastructure & Wastewater Generation in India/Study area	Ms. Sherona Cherian (UFZ)
10:00 am	1:30 pm	1	Introduction to the GIS-based ALLOWS Tool/Methodology	Dr. Ganbaatar Khurelbaat. (UFZ)
10:30 am	2:00 pm		Coffee Break (EU) / Lunch Break (India)	
11:00 am	2:30 pm	2	Data Processing and Image Classification Methodology	Ms. Sara Ramos (UFZ)
11:30 am	3:00 pm	2	Risk Analysis and Prioritization Map Preparation	Ms. Sherona Cherian (UFZ)
12:00 am	3:30 pm	2	GIS-based Sewer Network Design	Dr. Khurelbaatar, Sara R. (UFZ)
12:30 am	4:00 pm	2	Economic analysis of the scenarios: ALLOWS cost assessment	Dr. Ganbaatar Khurelbaat. (UFZ)
13:00 am	4:30 pm	2	Day 1 Wrap up and Highlights on Day 2 Schedule	Dr. Rahman, Dr. Khurelb. (UFZ)

Zoom-link: <https://zoom.us/j/99877634420?pwd=RkNraXVpK09ZemN0U1VBRVJWmNvEvQT09> (Meeting-ID: 998 7763 4420, ID-Code: 294889)



EU-India Water Technology & Management Project



European Commission



Department of Science and Technology, Government of India



Training Workshop Agenda (Day 2)

Day 2 (15.07.2021, Thursday)

Time (CET)	Time (IST)	Session	Session Theme	Presenter (Institute Name)
9:00 am	12:30 pm	3	State-of-the-art Wastewater Treatment Technologies, Wastewater Management and Reuse	Dr. Khaja Rahman (UFZ)
9:30 am	1:00 pm	3	Decentralised & Centralised Sewage Management: an Indian experience	Dr. Girish R. Pophali (CSIR-NEERI, India)
10:00 am	1:30 pm	3	PAVITR: Resource Recovery Potential	Carlos A. Arias, Ph.D. (Aarhus University, Denmark)
10:30 am	2:00 pm		Coffee Break (EU) / Lunch Break (India)	
11:00 am	2:30 pm	4	Potential Technical Measures and Economic Evaluation	Ms. Sherona Cherian (UFZ)
11:30 am	3:00 pm	4	Development and Evaluation of Sanitation Management Scenarios	Ms. Sara Ramos (UFZ)
12:00 am	3:30 pm	4	Q&A Session – Open Discussions	All Participants
13:00 am	4:30 pm	4	Day 2 Wrap up, Concluding Remarks and Highlights on 2 nd Training Workshop	Dr. Khaja Rahman (UFZ) & Dr. Ganbaatar Khurelbaat. (UFZ)

Zoom-link: <https://zoom.us/j/99877634420?pwd=RkNraXVpK09ZemNOU1VBRVJWmEvQT09> (Meeting-ID: 998 7763 4420, ID-Code: 294889)



Appendix 2:

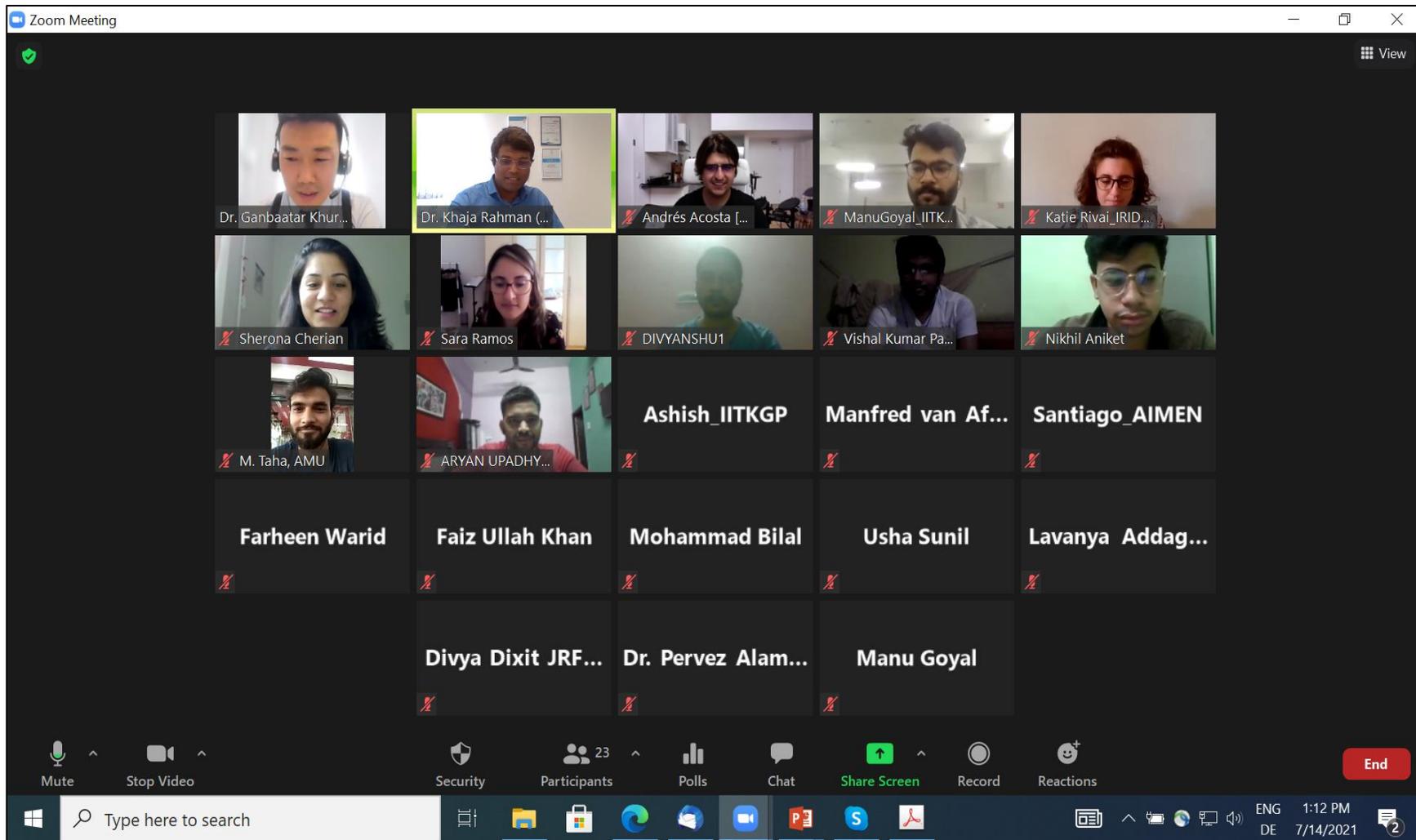
List of the Training Workshop Attendees/Participants *(provided on a voluntary basis during the workshop)*

	Name of attendees	Organization / Country	Position / Job Title
1.	Ilma Arshad		
2.	Aslam Khan	Aligarh, UP, India	Senior Professional, water and wastewater (consultant)
3.	Ms. Radhika Boargaonkar	Ecosan Services Foundation, Pune, India	Project Manager
4.	Dr. Pervez Alam	BGSB University, Rajouri, J & K, India	Assistant Professor
5.	Prasanna Katte, M.Tech.	IIT Kharagpur, India	Water Management
6.	Dr. Ganbaatar Khurelbaatar	UFZ, Germany	Senior Researcher
7.	Dr. Khaja Rahman	UFZ, Germany	Senior Researcher
8.	Dr. Manfred van Afferden	UFZ, Germany	Leader of the working group “Decentralized Wastewater Management”, Dept. UBZ, UFZ
9.	Ms. Sherona Cherian	UFZ and TUD, Germany	M.Sc. in Hydrosociences and Engineering
10.	Ms. Sara Ramos	UFZ and TUD, Germany	M.Sc. in Hydrosociences and Engineering
11.	Prof. Dr. Nadeem Khalil	AMU, Aligarh, India	Professor, Dept. of Civil Engineering, AMU Aligarh
12.	Carlos A. Arias, Ph.D.	Aarhus University, Denmark	Senior Researcher, Department of Biology, AU
13.	Vishal Kumar Parida	AMU, Aligarh, India	
14.	Ashish	IIT Kharagpur, India	
15.	Juan A Alvarez	AIMEN Technology Centre, Spain	Research Strategy Manager
16.	Santiago Gómez Cuervo	AIMEN Technology Centre, Spain	Research & Development
17.	Fahim Un Nisa	AMU Aligarh, India	Research student, Department of Geology, AMU
18.	Satya Pallagani	Worked for Rural WatSan Project funded by World Bank, UP, India	Freelance Consultant,
19.	Mohammad Bilal	Politecnico di Milano, Italy	M.Tech ,

	Name of attendees	Organization / Country	Position / Job Title
20.	Duduku Saidulu	IIT Kharagpur, India	PhD, Environmental Engineering
21.	Farheen Warid	AMU Aligarh, India	Ph.D Geography
22.	Nikul Kumari Sharma	Dr. A.P.J. Abdul Kalam Technical University (APJAKTU)	M.Tech., AKTU
23.	Salman Husain	AMU Aligarh, India	M.Tech Student, environmental Engineering
24.	Mr. Pranav Sankapal	SIU, Pune, India	JRF
25.	Nikhil Aniket	Dr B.R. Ambedkar National Law University Sonapat, India	Research Intern
26.	Divyanshu Sikarwar	School of Environmental Science and Engineering,	M.Tech Student
27.	Divya Dixit	CSIR-NEERI, NAGPUR	JRF, NEERI
28.	Manu Goyal	IIT, Kharagpur (dept. of civil engineering)	M.Tech,
29.	Vishal Kumar Parida	IIT, Kharagpur, India	Research Scholar
30.	Manoj Kumar Yadav	IIT, Kharagpur, India	Research Scholar
31.	Addagada Lavanya	CSIR – NEERI, India	Research Associate -1
32.	Abhradeep Majumder	IIT, Kharagpur, India	School of Environmental Science and Engineering, IIT, Kharagpur
33.	Divya Dixit	CSIR – NEERI, Nagpur, India	JRF
34.	Aryan Upadhyay	AMU Aligarh, India	Civil Engineering Dept., AMU
35.	Kathryn Rivai	IRIDRA Srl, Italy	
36.	Muddassar Taha	AMU Aligarh, India	JRF, Department of Civil Engineering, AMU, Aligarh
37.	Ashish Srivastava	IIT, Kharagpur, India	Research Scholar, School of Environment Science and Engineering, IIT Kharagpur
38.	Afreen Haidery	AMU Aligarh, India	Research Scholar, Dept. of Geology, Aligarh Muslim University
39.	Abdul Sami	AMU Aligarh, India	Research Student, M.Tech, Environmental Engineering, AMU
40.	Anurag Yadav	AMU Aligarh, India	Research Scholar, Dept. of Civil Engineering, AMU
41.	Shahnawaz Jami		
42.	M.Sc.- Ing. Andrés Acosta	ttz Bremerhaven, Germany	Project Leader of the PAVITR project

Appendix 3:

Group Photo: from Day 1 proceedings (provided on a voluntary basis during the workshop)



Group Photo: from Day 2 proceedings *(provided on a voluntary basis during the workshop)*

