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PAVITR Toolkit - Version 1

Final Version

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

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1. Executive Summary

The development of the PAVITR toolkit (Task 8.3) is one of PAVITR's main dissemination activities. The PAVITR toolkit is a collection of short, comprehensive factsheets outlining technical and non-technical aspects and success factors for sustainable replications of technologies and approaches piloted in PAVITR, grouped in the following thematic layers:

- **Identifying and setting up a project**: about determining *target communities and locations, understanding the challenges in a given context* and matching them with potential solutions
- **Getting to know PAVITR technologies**: to support *technology choice*, capturing main considerations to characterize their suitability
- **Resource reuse and recovery option(s)**: about analysis of *supply and demand* for treatment *inputs and outputs*, and identifying potential *business opportunities*
- **Governance and Operations**: about appropriate *institutional set-up of PAVITR projects* to meet management- and legal requirements
- **Understanding financial viability aspects**: introducing readers to *financial key components*, basics in *business modelling* and *innovative financing models* for water and sanitation projects
- **Considering the impact on Health and Environment**: presenting key results of *environmental & health impact assessments* of selected PAVITR pilots
- **Understanding water management options in a regional context**: summarising main learnings of implementing the ALLOWS tool
- **Pilot studies** harnessing our lessons learned from *implementation and operation practice* in selected PAVIR pilots

Contents will be presented in a pedagogic, low-entry level way so they are understandable for both an expert and non-expert audience and shall serve as helpful information source for practitioners bringing added value to already existing literature. It will be presented and freely online accessible as part of the Sustainable Sanitation and Water Management Toolbox (SSWM toolbox; https://sswm.info/) and encapsulate knowledge, lessons learned, and insights created during the implementation of the PAVITR.

According to agreement with the project officer, this present deliverable is the first of two deliverables to report on the status of Task 8.3, with the second presenting the final version in January 2023. Depending on the results elaborated in 2020, the toolkit content and working titles presented in this deliverable will be adapted / updated.

2. Background and Objective

There is a large number of practitioners and researchers within and outside of India who could benefit from PAVITR results, specifically when it comes to their efforts to

- choose sustainable technical solutions for a water/sanitation related challenge assuring that the technology fits its purpose while meeting locally available budget-, staff- and infrastructure capacities as well legal requirements
- collect and treat peri-urban wastewater streams and valorize the treatment process and its byproducts through resource reuse and/or recovery
- contribute to solving long-term problems related to food security, health and environmental protection

Thus, main objective of task 8.3 is to make key project results that otherwise would be scattered and/or siloed accessible to a wider audience beyond the project participants and their immediate network.

Specifically, we are targeting the following audience

- Impact-driven entrepreneurs such as engineers, urban planners, consultants, building developers
- Intrapreneurs such as employees of utility service providers or local government bodies
- Municipalities and regional governments in need of low-tech, water and sanitation solutions
- Private sector parties in need of water management and reuse options (e.g.: for worker residential colonies, office buildings etc.)
- Financing institutions / donors in need of decision-making support for comparing different regional water management scenarios (→ ALLOWS tool)
- Local teaching institutions / organizations who could use toolkit as basis for creating regular courses for e.g. students or community members

Focusing on a holistic planning and design approach for water and wastewater management, the toolkit is designed in a way to assure user-friendly, easy accessible content in form of short, informative texts summarizing key-aspects and providing links to additional/further (ideally open-access) high-quality reading materials.

By manoeuvring through the different thematic layers of the toolkit, the toolkit users will get to know presented PAVITR technologies, their supply and demand requirements, but also get acquainted with diverse aspects around identifying and specifying a particular water/sanitation challenge or the financial- as well as institutional set-up of a proposed solution. Moreover, insights on evaluating and optimising potential impacts on health and environment will be provided. There will also be a thematic layer on putting (waste-)water management in a regional perspective as well as one with case studies of selected PAVITR's pilot projects.

Summed up, users of the PAVITR toolkit benefit by receiving

- comprehensive, practice-oriented information
    - to identify (new) technologies and/or business ideas along the water cycle
    - to better understand potential technology combinations as well as financial and institutional aspects which are essential for their sustainable implementation
- links to further information/resources and contact points/network

- "food for thought" for reducing/covering O&M costs and environmental footprint of water and sanitation infrastructure and meeting water and sanitation challenges with system-oriented solutions
- Free access to a wide knowledge platform

3. Methodology

For designing the PAVITR toolkit and deriving contents, the following steps are taken:

1) **Conceptualisation** of toolkit reviewing experiences from previous Indo-EU projects (NaWaTech and Swings), available state-of-the art literature; screening of other openly accessible knowledge sharing portals/contents on the topic
2) **Drafting of factsheet templates and author checklist** to harmonize input and give guidance on expected format and content for each factsheet. Templates' finalization in collaboration with contributing authors
3) **Presentation of draft concept and templates** to EU and Indian project partners and joint agreement on final scope and division of work; identification of focus topics based on "lessons learned" workshops with project partners
4) **Delegation to authors & elaboration of contents:** Elaboration of text for each factsheet based on state-of-the art literature and project results; bilateral follow-up and iterative reviewing of drafted factsheets.
5) **Alignment/harmonization of contributions from different authors:** Final review and editing; shared responsibility of BOKU and seecon.

4. Proposed content for PAVITR Toolkit

4.1. Overview

A main assumption the PAVITR toolkit is built upon, is that in order to promote sustainable solutions for water and wastewater challenges, we need foster a more holistic perspective on water management and reuse going beyond the technologies per se.

This holistic perspective means to make efforts to comprehend a given context/problem to assure appropriateness and viability of potential solutions; it also means to work on aspects around financial recovery and institutional set-up to meet management- and legal requirements. It also refers to making resource reuse and recovery an inherent component of a project or the consideration of environmental and health impacts of potential options. Additionally, it means to look at water management not only on micro level for a particular case, but to look at challenges on a regional or even larger-grid level when comparing different available options and optimizing the set-up of a selected solution.

Based on this logic, the following thematic layers were identified to build the main skeleton of the toolkit:

- **Thematic Layer 1: Identifying and setting up a project**: about determining target communities and locations, understanding the challenges in a given context and matching them with potential solutions

- **Thematic Layer 2: Getting to know PAVITR technologies**: to support technology choice, capturing main considerations to characterize their suitability
- **Thematic Layer 3: Resource reuse and recovery option(s)**: about analysis of supply and demand for treatment inputs and outputs, and identifying potential business opportunities
- **Thematic Layer 4: Governance and operations**: about appropriate institutional set-up of PAVITR projects to meet management- and legal requirements
- **Thematic Layer 5: Understanding financial viability aspects**: introducing readers to financial key components, basics in business modelling and innovative financing models for water and sanitation projects
- **Thematic Layer 6: Considering the impact on health and environment**: presenting key results of environmental & health impact assessments of selected PAVITR pilots
- **Thematic Layer 7: Understanding water management options in a regional context**: summarising main learnings of implementing the ALLOWS tool
- **Thematic Layer 8: PAVITR Case Studies** lessons learned to get practical insights on challenges and solutions found during the implementation of our pilot projects in XX and XX.

The toolbox uses a 3-level structure in line with the existing logic structure of the SSWM portal distinguishing

Overall level (at SSWM portal also referred to as "Perspective"): "PAVITR Water & wastewater treatment, monitoring and reuse in India"

Sublevel 1 = Thematic Layer

Sublevel 2 = associated **Factsheets**

Proposed main contents for the Perspective landing page and the toolkit's thematic layers are presented in the following sub-sections.

Please note that the presented structure and factsheet titles are working titles and might be adaoted as more project results being made available in the course of 2022.

4.2. Perspective landing page "PAVITR's approach to tackling water challenges in India"

The following main contents are proposed to be included in this thematic layer:

- Short description of PAVITR toolkit, its purpose and approach, target audience and overview/structure
- Short summary of PAVITR project
- Visualization of thematic layers of the toolkit that users are invited to navigate through
- Key learnings for (un-)success factors for sustainable water/wastewater projects in India
- Short overview of key-challenges and gaps in India's water or/and wastewater management

4.3. Thematic layer 1 "Identifying a project"

For this thematic layer, the following main contents are proposed:

- **Factsheet "Identification of target community"**: how can practitioners identify (potential) projects; are there relevant (public) tenders or funding programs; Which problems did our partners face and which solutions did they find when selecting pilot projects and locations.
- **Factsheet "Matching of location and technology"**: functional requirements of technologies vs. available needs and capacities of a given context; Base-line data collection - why, how and what to be prepared for.
- Links to "Site selection" section on SSWM portal
- Links to problem analysis tools and methods section on SSWM portal
- Link to/reference to Module 1 Week 1 of RRR course on SSWM portal

4.4. Thematic layer 2 "Getting to know PAVITR technologies"

14 individual factsheets for each technology piloted in PAVITR capturing main considerations to characterise a technology's suitability: input/output, design considerations, appropriateness, O&M considerations, experiences in India and globally, further reading recommendations.

4.5. Thematic layer 3 "Resource reuse and recovery options"

Proposed main contents for this thematic layer:

- **Factsheet "Supply and demand analysis"**: analysis of waste supply and market demand for potential products
- **Factsheet "Identify potential Resource Recovery and Reuse business opportunities and limitations"**

4.6. Thematic layer 4 "Governance and Operations"

Proposed main contents for thematic layer:

- **Factsheet "Roles and responsibilities":** what are typical roles and their responsibilities in a water supply or wastewater management project
- **Factsheet "Key results of PAVITR's community of practice":** short overview of formal and informal stakeholder landscape, identified issues/capacity gaps by PAVITR CoP
- **Factsheet "Legal framework":** Short summary of or reference to relevant laws/regulations and standards; most relevant policy makers.
- Link to "Community Engagement and communication" on SSWM portal
- Link to "Setting up an Operator Model" on SSWM portal
- Link to "Participatory Governance Assessments" on SSWM portal
- (Link to "Sector engagement" once text is available)

4.7. Thematic layer 5 "Understanding Financial Viability Aspects"

Proposed main contents for this thematic layer:

- **Factsheet "Business Modelling"**: how to build business model around technology and reuse options

- **Factsheet "Understand the financial key components":** what are components like CAPEX, OPEX, revenues, cash flow, break-even point, margins, etc. and why do we have to be aware of them? Presentation of concepts to structure the costs of the systems along its life cycle.
- **Factsheet "Innovative financing models for water and sanitation":** Introduction to alternative financing models (e.g.: impact financing)

4.8. Thematic layer 6 "Considering the Impact on Health and Environment"

Proposed main contents for thematic layer: presentation of key results of Life Cycle Analyses of 3 selected pilot treatment systems to evaluate the system's potential impacts produced under Work Package 5.

4.9. Thematic layer 7 "Understanding water management options in a regional context"

Proposed main contents for thematic layer: key-learnings from implementing the ALLOWS Tool under Work Package 6; Introduction to the tool, summary of its advantages and disadvantages, general learnings

4.10. Thematic layer 8 "PAVITR Case studies"

The following main contents are proposed for this thematic layer:

- **Individual factsheets for (selected) PAVITR pilots:** describing key lessons learned in (selected) PAVITR pilots: challenges and solutions during the implementation process; performance, reflections concerning all thematic sections (see above).
- **(Optional: additional documents for practitioners** like e.g.: template contracts or quality control checklists for contracts, template MoUs, baseline data collection checklist, etc.)

5. Status of the work and timeline

Table 1 shows a short overview of the state-of-work regarding the development of the PAVITR toolkit based on the working steps / approach presented in section 3 "Methodology".

Table 1: Status of the PAVITR toolkit development (January 2022).

Working step	Status January 2022
Conceptualisation	- Concept note drafted in July/August 2020; reviewed March/April 2021 incorporating delays induced by Covid-19 Pandemic. - Final review of concept note in Oct. 2021 - Final version of concept note available → **see Annex 1**
Drafting of factsheet templates and author checklist	- Finalisation of author checklist in March/April 2021 - Finalisation factsheet templates for thematic layer (TL) 2 in May/June 2022 → **See Annex 2** - Draft Templates for TL 3, 5, 7 and 8 in September/October 2021 (still to be adapted with more project results becoming available) - Draft templates for TL 1 and 4 still to be elaborated
Presentation of draft concept and templates	- Presentation and discussion of concept and task strategy to EU partners in May 21; author checklist and templates for technology factsheets shared in May-July 2021 - Presentation to Indian LP in July/August 2021 - Presentation to Indian partners in Nov/Dec 2021; author checklist and template for technology factsheets shared in Dec 21
Delegation to authors & elaboration of contents	- TL1: literature review started; factsheet elaboration pending (**BOKU**, to be decided) - TL 2: collaboration with EU authors May-Oct 21: final drafts for 10 technology factsheets available → **see Annex 3**; 1 FS draft pending; collaboration with Indian authors for 3 technology factsheets started in Dec 21 and still on-going (**BOKU**, IRIDRA, Bioazul, Kreta, UPC, TTZ, AIMEN, PESSL, NEERI, LARS ENVIRO) - TL 3: Factsheets drafted and to be finalised as more project results become available (**Seecon**, AU, TTZ, to be decided) - TL4: literature review started; factsheet elaboration pending (**BOKU**, to be decided) - TL 5: Factsheets drafted and to be finalised as more project results become available (S**eecon**, to be decided) - TL 6: initial discussions held with TTZ; elaboration pending (TTZ) - TL 7: Factsheet drafted and to be finalised as more project results become available (**UFZ**) - TL 8: elaboration pending (**BOKU**, IRIDRA, Bioazul, Kreta, UPC, TTZ, AIMEN, PESSL, to be decided)
Alignment/harmonization of contributions from different authors	On-going
Upload	Version 1 Beta Version of Toolkit to be uploaded in Jan 2022: containing structure and proposed thematic layers of the toolkit → **See Annex 4** Version 2 – Final Version to be uploaded in Jan 2023

6. Annex

6.1. Annex 1 Concept Note for PAVITR Toolkit

PAVITR Toolkit

Concept Note

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1. Executive Summary – What is the PAVITR toolkit?

The development of the PAVITR toolkit (Task 8.3, Deliverable 8.9) is one of PAVITR's main dissemination activities. The PAVITR toolkit will be a collection of short, comprehensive factsheets outlining technical and non-technical aspects and success factors for sustainable replications of technologies and approaches piloted in PAVITR, grouped in the following thematic layers:

- **Identifying and setting up a project**: about determining *target communities and locations*, *understanding the challenges and context* and matching them with potential solutions
- **Getting to know PAVITR technologies**: to support *technology choice*, capturing main considerations to characterize their suitability
- **Resource reuse and recovery option(s)**: about analysis of *supply and demand* for treatment *inputs and outputs*, and identifying potential *business opportunities*
- **Governance and Operations**: about appropriate *institutional set-up of PAVITR projects* to meet management- and legal requirements
- **Understanding financial viability aspects**: introducing readers to *financial key components*, basics in *business modelling* and *innovative financing models* for water and sanitation projects
- **Considering the impact on Health and Environment**: presenting key results of *environmental & health impact assessments* of selected PAVITR pilots
- **Understanding water management options in a regional context**: summarising main learnings of implementing the ALLOWS tool

Contents will be presented in a pedagogic, low-entry level way so they are understandable for both an expert and non-expert audience and shall serve as helpful information source for practitioners bringing added value to already existing literature. It will be presented and freely online accessible as part of the Sustainable Sanitation and Water Management SSWM toolbox and encapsulate knowledge, lessons learned, and insights created during the implementation of the PAVITR.

2. Target audience and their needs

Below we describe who are we intending to target specifically taking into account expected information needs of the respective audience(s).

2.1. User segments:

Primary (direct):

- Impact-driven entrepreneurs such as engineers, urban planners, consultants, building developers
- Intrapreneurs such as employees of utility service providers or local government bodies

Secondary (indirect):

- Municipalities and regional governments in need of low-tech, water and sanitation solutions
- Private sector parties in need of water management and reuse options (e.g.: for worker residential colonies, office buildings etc.)
- Financing institutions / donors in need of decision-making support for comparing different regional water management scenarios (→ ALLOWS tool)
- Local teaching institutions / organizations who could use toolkit as basis for creating regular courses for e.g. students or community members

2.2. User needs:

- Choice of a sustainable technical solution for a water/sanitation related challenge assuring that the technology fits its purpose while meeting locally available budget-, staff- and infrastructure capacities as well legal requirements
- Collection and treatment of peri-urban wastewater streams and valorization of treatment process and its byproducts through resource reuse and/or recovery
- Contribution to solving long-term problems related to food security, health and environmental protection

3. Objective and value proposition

Knowledge gathered in the project that otherwise is scattered and/or siloed, is made accessible to a wider audience beyond the project participants and their immediate network.

Manoeuvring through the different thematic layers of the toolkit, the users will get to know the presented technologies, their supply and demand requirements, but also get acquainted with diverse aspects around identifying and specifying a particular water/sanitation challenge or the financial- as well as institutional

set-up of a proposed solution. Moreover, insights on evaluating and optimising potential impacts on health and environment will be provided. There will also be a thematic layer on putting (waste-)water management in a regional perspective as well as one with case studies of selected PAVITR's pilot projects.

Specifically, the users will learn about

- the most common barriers to more sustainable (waste)water treatment, monitoring and reuse in India
- specifying a water or/and wastewater challenge and identifying potential sites and locations
- rapidly assessing the most suitable technological options for their water project/challenge
- setting-up their project in holistic manner where technology comes with its appropriate institutional and financial embedding
- tools for identifying stakeholders important for / or impacted by the project, assessing their interests and power structure(s); and for getting relevant stakeholders engaged in a project
- the different roles and responsibilities involved when setting up and implementing a W&WW project
- resource reuse and/or recovery options as fundamental model when tackling water and sanitation challenges, including conducting an analysis of supply and demand for the presented technologies, as well as to identify corresponding business opportunities
- key results of assessments of impact on health and environment of (selected) technologies
- legal bases for setting up a (drinking water or) wastewater project and relevant actors in the sector
- identifying business opportunities and screening the business landscape
- typical challenges of financing water and sanitation solutions
- innovative financing approaches and how to utilize them to achieve better financial performance in water and sanitation"
- embedding local water or wastewater systems within a regional framework of water and sanitation management schemes to facilitate regional planning and how this can be achieved by using the ALLOWS tool
- lessons learnt in selected PAVITR pilot sites ("case studies")

4. Structure and design principles

The structure of the toolkit is based on the assumption that in order to provide *sustainable* solutions for water and sanitation challenges, it is not enough to consider technologies and their performance only, but one needs to thoroughly *comprehend the given context/problem*, the applicability and viability of

potential *technological options*, and to assure *reuse or recovery of processed resources* wherever possible. Also, it requires to incorporate aspects around the solutions' *financial viability*, but also its appropriate *institutional set-up* to *meet its management- and legal requirements*. Considering aspects around *environmental & health impacts* but also looking at water management on a broader level (e.g.: regional perspective), can facilitate the comparison of different available options and help in optimizing the set-up of a selected solution.

4.1. Structure

The toolbox will encompass the following chapter and will be follow a 3-level structure distinguishing

Overall level = "Perspective"

- **Sublevel 1 = Thematic Layer**
  - **Sublevel 2 = Associated Factsheets**

4.2. Proposed Content

Perspective "PAVITR's approach to systemically tackling water challenges"

Landing page:

Proposed main contents for entry text:

- Short description of PAVITR toolkit, its purpose, target audience and overview/structure
- Short summary of PAVITR project
- Visualization of thematic layers of the toolkit that users are invited to navigate through
- key learnings for (un-)success factors for sustainable water/wastewater projects in India (based on D1.1 and literature review, expert input)
- Short overview of key-challenges and gaps in India's water or/and wastewater management (based on D 1.2 and D 1.2 and literature review, expert input)
- short explanation of our "point of view" why we selected these thematic layers and how they can be used to shape your (waste-)water solution (interconnection of aspects. Thematic layers not to be read in a linear manner neither to be understood as all encompassing planning approach, but rather guidance to different aspects that need consideration when setting up a project and when doing feasibility checks ;
  distinction from (complementation to) existing SSWM chapters like i.e. "Sanitation project implementation" perspective: our focus lies on India (v.s. Middle East), water/wastewater/rainwater treatment technologies, but also high resolution monitoring (lab- and mobile field approaches), RRR models, (financial viability/business aspects, risk and impat assessments), also we incorporate the regional planning view

Thematic Layer 1 "Identifying a project"

Section landing page: What is this section about; Identifying potential project communities and locations and matching with technology options as delicate but vital starting point

Factsheets

- Identification of target community: how can practitioners identify (potential) projects: what are relevant (public) tenders or funding programs that need to be followed (NMCG, regional or local sanitation development plans etc.). Which problems did our partners face and which solutions did they find when selecting pilot projects and locations. E.g. based on expert interviews, inputs of project partners.
- Matching of location and technology: theory on what you ideally consider; based on functional criteria checklists and feedback of implementing partners
- Baseline data collection/analysis: based on D1.1 and input of designing partners
- Links to "Site selection" section (https://sswm.info/sanitation-project-implementation/site-selection) und Regional Planning Section (PAVITR)

- Links to problem analysis tools and methods section on SSWM portal

  Link to/reference to Module 1 Week 1 of RRR course "Identify challenges in your local sanitation and waste management"; locality map RRR course

Thematic Layer 2 "Getting to know the PAVITR technologies"

Section landing page: What is the section about and how does it link-up to the other sections; Why we must consider suitability/applicability aspects when getting to know or comparing technologies/technological options.

Factsheets

- **Individual factsheets for each PAVITR technology** that captures main considerations to characterise its suitability: e.g. input/output, design considerations, appropriateness, O&M considerations, experiences in India and globally, further reading recommendations.
- once available, also integration of "optimisation experiences" → either in tech factsheets or as separate summary learnings e.g. per Research Cluster

Thematic Layer 3 "Resource reuse and recovery option(s)"

Section landing page: What is this section about and how does it link up to other sections; short description why reuse matters, what it can do for sustainability, etc.; reference to legal framework paper in other section

Factsheets

- **Supply and demand analysis**: analysis of waste supply and market demand for potential products
- **Identify potential RRR business opportunities and limitations** Based on RRR Online Course Materials / IWMI's book on RRR and results of WP4

Thematic Layer 4 "Governance and Operations

Section landing page: What is this section about and how does it link up to other sections; what do we mean by governance and operations. Why is that relevant.

Factsheets

- **Roles and responsibilities:** Adaptation of NaWaTech working material; needs to also be made applicable for water treatment project, review by implementing partners / selected examples of PAVITR project
- **Key results of PAVITR's community of practice:** short overview of formal and informal stakeholder landscape, related issues/capacity gaps
- **Legal framework:** Short summary of or reference to relevant laws/regulations and standards; most relevant policy makers. Based on D1.1 + Update by Indian Project Lead!
- Link to "Community Engagement and communication" (https://sswm.info/sanitation-project-implementation/participatory-planning-and-community-engagement/community-engagement-&-communication)
- Link to "Setting up an Operator Model" (https://sswm.info/sanitation-project-implementation/governance-and-operations/setting-up-an-operator-model)
- Link to "Participatory Governance Assessments" (https://sswm.info/sanitation-project-implementation/governance-and-operations/participatory-governance-assessments)
- (Link to "Sector engagement" (once text is available) https://sswm.info/sanitation-project-implementation/sector-engagement)

Thematic Layer 5 "Understanding Financial Viability Aspects"

Section landing page: What is this section about and how does it link up to other sections

Factsheets

- **Business Modelling**: Build business model around technology and reuse option
- **Understand the financial key components:** What are components like CAPEX, OPEX, revenues, cash flow, break-even point, margins, etc. and why do we have to be aware of them? Presentation of concepts to structure the costs of the systems along its life cycle.
- **Innovative financing models for water and sanitation:** Introduction to alternative financing models (e.g. impact financing)

Thematic Layer 6 Considering the Impact on Health and Environment

Section landing page: What is this section about and how does it link up to other sections

Factsheets

- **Environmental and health impacts**: key results of Life Cycle Analyses of 3 selected pilot treatment systems to evaluate the system's potential impacts
- **Risk assessment: ??**

Thematic Layer 7 "Understanding water management options in a regional context"

Section landing page: What is this section about and how does it link up to other sections

Factsheet

- **Key-learnings from implementing the ALLOWS Tool:** Introduction to the tool, summary of its advantages and disadvantages, general learnings

Thematic Layer 8: PAVITR Case Studies → Case studies of (selected) pilot projects

Section landing page: What is this section about and how does it link up to other sections

Case Study Factsheets

- **Pilot study X:** describing key lessons learned in (selected) PAVITR pilots: challenges and solutions during the implementation process; performance, reflections concerning all thematic sections (see above) .
- **Additional documents for practitioners:** template contracts or quality control checklists for contracts, template MoUs, baseline data collection checklist, etc.

4.3. Design Principles

- User-friendly and accessible content: short, informative texts summarizing key-aspects and providing links to additional/further (ideally open-access) high-quality reading materials; also cross-referencing to other projects or existing contents of SSWM toolbox
- Focused on the holistic planning and design approach as well as on the empowerment of the user

5. Contribution to PAVITR project sustainability

Prepares grounds for replication of PAVITR solutions and follow-up of PAVITR projects by

- Capturing most important engineering- and business-oriented project outputs and making sure knowledge is made available beyond project duration and summarized in a pedagogically suitable way
- Elaborating which aspects to consider for moving from "piloting" towards sustainable replication and implementation of PAVITR solutions

6. Value creation & delivery

1.1 Value creation

- Comprehensive, practice-oriented information
  - to identify (new) technologies and/or business ideas along the water cycle
  - to better understand potential technology combinations as well as financial and institutional aspects which are essential for their sustainable implementation
- Provides links to further information/resources and contact points/network
- Provides "food for thought" to practitioners for reducing/covering O&M costs and environmental footprint of water and sanitation infrastructure and meeting water and sanitation challenges with system-oriented solutions

6.1. Value delivery

- Free accessible webpage
- Capacity building / match-making workshop(s) → Link to WP 7 and WP9

7. Workplan

7.1. Methodological steps and responsibilities

1) **Specification of contents:** the first step consists of looking into the user base of the NaWaTech toolkit NaWaKit to better understand what information is most in demand. This task can be spearheaded by seecon. The findings should be contrasted with statements from key experts from India and complementary web research.
2) **Presentation of draft concept to partners and joint agreement on final scope and division of work**
3) **Drafting of chapter templates/structures:** based on (1) the format and structure of each chapter including guiding questions for project partners will be developed. This will help to decide which contents will be elaborated by co-authors, but also to harmonize contributions and make sure the chapters capture the expected contents.
4) **Delegation to authors & elaboration of contents:** bilateral communication & follow-up with co-authors. Elaboration of text for each chapter. Responsibilities → see (2)
5) **Alignment/harmonization of contributions from different authors:** collection of different inputs, review and editing; shared responsibility of BOKU and seecon.

1.1 Timeline

Draft concept (audience, objectives, structure and content etc.) ready	15.04.2021
Check which contents are already available on SSWM toolbox and can/need to be adapted or linked to	15.04.2021
First set of templates for new factsheets/ tool descriptions ready	15.05. 2021
Presentation of concept (scope and division of work) to EU project partners	May 2021
Development of desk-work-based factsheets (Technology Factsheets, ALLOWS factsheet)	1.6.-30.11.2021
Presentation of concept to Indian project partners	Nov 2021
Preparation and Upload of First Toolkit version	Jan 2022
Selection of case studies	Aug 2022
Development of all remaining factsheets	Oct 2022
Development of Pilot Case Studies	Oct 2022
Final review of all contents and final editing ready	Nov/Dec 2022
Technical implementation in PAVITR platform ready	Feb 2023 (M48)

6.2. Annex 2 Example of factsheet template for "Technology Factsheets"

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TECHNOLOGY FACTSHEET

Title of Technology *written out, no abbreviation*	[Title]
Author / Compiled by *Name(s) & Institution(s) of author(s) OR if you have adapted the whole contribution from one publication, it is enough if you specify this here and make sure the publication is part of the references below*	[Name Family Name], ([Name of Institution]) OR [Author of publication], ([Year])
Executive Summary *Sum up in maximum 15 lines how the technology works and for which applications it is suitable for* *Max. 100 words*	[Text]
Input/Output *Please tick (type an X) which type of input the technology can handle and what type of output is produced*	**Inputs:** ☐ Groundwater sources (borehole, spring) ☐ Bankfiltrated water ☐ Surface water (ponds, rivers, lakes) ☐ Rainwater ☐ Raw domestic wastewater (blackwater) ☐ Degreased, screened sewage ☐ Primary sludge (from e.g. settling tank) ☐ Faecal sludge (from e.g. septic tanks or cesspits) ☐ Industrial wastewater ☐ Hospital wastewater ☐ Other: **Outputs** ☐ Primary treated effluent ☐ Secondary treated effluent ☐ Tertiary treated and/or disinfected effluent ☐ Biomass ☐ Biogas ☐ (Biofertilizer) ☐ Disinfected effluent for fertigation (nutrient rich) ☐ Disinfected effluent for irrigation ☐ Disinfected effluent for toilet flushing or higher quality applications ☐ Primary sludge ☐ Faecal sludge ☐ Secondary sludge ☐ Soil conditioner or composted dehydrated sludge ☐ Other:
Removal of *Please tick (type an X) for which quality parameters significant removal rates can be expected*	☐ Total suspended solids (TSS) ☐ Total dissolved solids (TDS) ☐ NH4-N ☐ N_{tot} ☐ Phosphor

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	☐ Organic compounds / COD / BOD5 / TOC ☐ Pathogens ☐ % Total Solids (for sludge) ☐ Volatile fatty acids ☐ Sludge toxicity ☐ Iron ☐ Manganese ☐ Arsenic ☐ Fluoride ☐ Ammonium
Design considerations *Describe the technology's basic design principles and how the treatment process works.* *Include a basic drawing of the main components and flows. Position the drawing where you would like it to appear in the text. Don't forget to also store the jpeg/png in the submission folder.* *Max. 250 words*	[Text] [***Subtitle***] [Text - Bullets - Bullets - …]
Appropriateness *Shortly characterize for which applications/contexts this technology is best used and where it cannot be used at all taking into account* - *susceptibility to certain operating conditions (e.g.: hydraulic fluctuations, shockloads, extensive dry or high temperature periods, flooding)* - *land requirements (e.g.: is it a compact solution or does it have considerable space requirements)* - *infrastructure (e.g.: construction materials that require shipping from afar; requirements for tap connection, continuous power supply; accessibility needs for trucks beyond construction period etc.)* ***Max. 250 words***	[Text] [***Subtitle***] [Text - Bullets - Bullets - …]
Operation and Maintenance *Describe the most relevant consumables, infrastructure and activities (including services by third parties) required to safely and efficiently operate and maintain the system.* *Note the level of skills staff is expected to have.* *Max. 150 words*	[***Subtitle***] [Text - Bullets - Bullets - …]

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TECHNOLOGY FACTSHEET

Experiences in India *Briefly describe experiences (others) made with using this technology in India, describing aspects like* - *the context it was applied in* - *costs involved* - *performance observed* - *challenges/solutions found* *Max. 200 words*	
Experiences Globally *Briefly describe experiences (others) made with using this technology in India, describing aspects like* - *the context it was applied in* - *costs involved* - *performance observed* - *challenges/solutions found* *Max. 200 words*	
Abbreviations and Glossary *Abbreviations: List all abbreviations you have used and spell them out in the column "Term"* *Glossary: explain some specific terms which may not be clear but which are not sufficiently important to be explained in the text.* *Please list all terms them in an alphabetic order.*	
Reference List *List all references you have used in the text in alphabetic order.* *Please follow the instructions in the CHECKLIST to correctly format your references.*	[Reference] …

Term	Abbreviation	Definition	Reference for Definition
World Health Organisation	WHO	-	-
Sustainable Sanitation		The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources.	http://www.susana.org/lang-en/sustainable-sanitation [Accessed: 20.04.2012]

Further Reading Material

Further Reading *List max. 10 useful and important* ***open***	[Title of document A Short description

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TECHNOLOGY FACTSHEET

***source** documents about the topic like* - *articles and literature* - *training material* - *case studies* - *awareness raising material* *and provide a short description of each of them.* *Mark the material that is of particular importance in bold.* *Please try to avoid files larger than 5Mb by compressing them or only adding them if they are of great added value.* *Max. 80 words description per document*	Reference] [Title of document B Short description Reference] …
Important Web Links *List at least 3-4 important web links about the topic, like for example* - *websites, where further information can be found* - *interesting project websites* - *relevant open access videos* *Provide a short description) for each link you list.* *Max. 40 words description per link.*	[Link A (use full link; incl. http://www. Accessed: DD.MM.YEAR] Description link A.] Link B (use full link; incl. http://www. Accessed: DD.MM.YEAR Description link B.] …

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6.3. Annex 3 Example of a Final Draft for a Technology Factsheet (Thematic Layer 2)

Perspective

Getting to know PAVITR technologies (/pavitr-toolkit/getting-know-pavitr-technologies)

Factsheet

High Rate Algal Ponds (HRAPs)

Author/Compiled by
Enrica Uggetti (Universitat Politècnica de Catalunya-BarcelonaTech)
Antonio Ortiz (Universitat Politècnica de Catalunya-Barcelon

Executive Summary

HRAPs are cost-effective systems designed to enhance wastewater treatment and microalgal biomass production. Here microalgae assimilate nutrients from wastewater and produce the oxygen needed by bacteria to oxidize the organic matter. The symbiosis between bacteria and microalgae leads to the production of: 1) clean water suitable for reuse, and 2) algal biomass that can be converted in bioproducts such as biofertilizers, biostimulants, biogas, pigments, bioplastics, etc.

The treatment is suitable for the treatment of urban and industrial wastewater, digester effluent, piggery and dairy farm wastewater, etc.

Input/Output

Input:

Groundwater sources (borehole, spring)

Surface water (ponds, rivers, lakes)
Rainwater
Groundwater sources (borehole, spring)
Industrial wastewater

Output:

Primary treated effluent
Secondary treated effluent
Biomass
(Biofertilizer)

Removal of...

Total suspended solids (TSS)
Total dissolved solids (TDS)
NH4-N
Ntot
Phosphor
Organic compounds / COD / BOD5 / TOC
% Total Solids (for sludge)
Ammonium

Design considerations

HRAP systems consist of two main parts: a shallow raceway with paddlewheels where wastewater treatment is carried out by microalgae and bacteria, and a harvesting unit to separate the biomass from the clean water.

In HRAPs, pre-treated wastewater is gently moved by paddlewheels. Microalgae use sunlight energy to grow, remove the nutrients from the wastewater, and produce oxygen through photosynthesis. The oxygen is used by aerobic bacteria to oxidize the dissolved organic matter (PASSOS et al. 2017)

Organic loading rate, depth, hydraulic retention time and horizontal mixing velocity are the main operational control variables for HRAPs. Depending on the climate, the maximum organic loading rate of HRAPs is between 100 and 150 kg BOD5·ha−1·d. HRAP depth is dependent on wastewater clarity (typically 0.2–0.6 m). In temperate climates, hydraulic retention time varies seasonally (3–4 d in summer and 7–9 d in winter). Paddlewheel mixing (typically 0.15–0.30 m s−1) causes turbulent eddies that provide a vertical mixing component within the pond so that microalgal cells are intermittently exposed to sunlight. The annual biomass productivity of wastewater treatment HRAPs at moderate latitudes is typically 30 t·ha−1·y (Craggs et al., 2014).

The biomass is collected through the harvesting units, then can consist of a gravity settler or a Dissolver Air Flotation system (DAF).

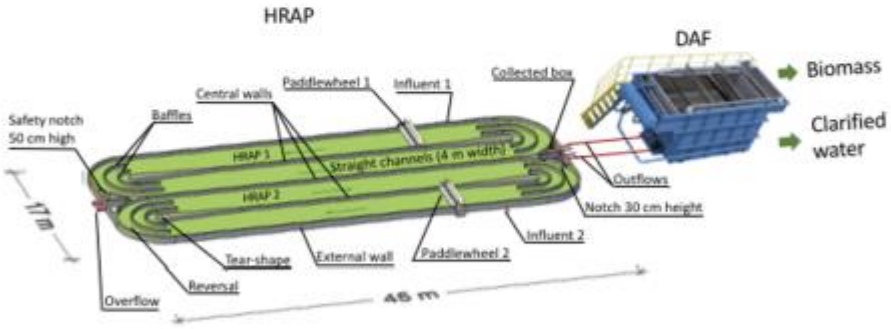

Figure 1. Example of HRAPs design developped in the framework of the PAVITR project. The HRAPs are built in Aligarh (India).

Suitability

This system is based on the microalgae-bacteria synergy, and it is suitable both for nutrients and organic matter removal from different types of wastewater (urban, industrial, etc.). Pre-treatment with a gravity settler is normally needed to remove part of the solids.

Due to its quite high land requirement (3-5m2/PE), it is mainly suitable for small communities (2,000 PE), however it could be used for communities of up to 10,000 PE.

HRAP are biological systems based on photosynthetic microorganisms, thus they are working properly in warm and sunny climate. Unfavourable climatic conditions can strongly compromise the system's performances in terms of wastewater treatment and biomass production.

HRAP systems are characterized by low implementation, operation and maintenance costs. HRAPs can be built with materials that are normally easily available locally, such as bricks, concrete, steel or PVC (no transport needed). Also, the energy need of HRAPs (0.020 kWh/m3) is considerably lower than of conventional wastewater treatment technologies such as activated sludge (0.20-0.4 kWh/m3). Even though HRAPs do not require highly specialized operation and maintenance staff, they require trained personal (see O&M tasks below).

Operation and Maintenance

For the correct HRAPs operation the following monitoring probes are needed:

- pH

-Temperature

-Dissolved oxygen

- Water lever

The main operation and maintenance activties are:

- checking and maintenance of the probes (weekly cleaning and calibration)
- verification of inflow and outflow pumps, as well as proper paddlewheel operation
- measurement of the turbidity of the DAF effluent

For such operations, basic knowledge in electronics are required.

Main consumables:

- Monitoring probes

- Coagulant (e.g. polyaluminium chloride) for DAF

Laboratory reagents to clean the sensors

Experiences in India

As far as we know, by the time this factsheet was compiled (2021), previous to the PAVITR project, HRAPs were not yet used in India. The PAVITR pilot in Aligarh Muslim University seems to be the first documented application.

Experiences Globally

Experiences with the application of HRAPs at large scale are still very limited. Some systems are built in California and Australia (PARK & CRAGGS 2010). Nowadays in Spain the company FCC Aqualia S.A. is running some largescale facilities in the south of Spain. However, literature around their experiences is unfortunately only available in Spanish language (DE GODOS et al. 2013).

Abbreviations and Glossary

Term	Abbreviation	Definition	Reference for Definition
Biological Oxygen Demand	BOD	BOD is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a surrogate of the degree of organic pollution of water.	Metcalf and Eddy, 2004
Dissolved air flotation	DAF	Dissolved air flotation (DAF) is a water treatment process that clarifies wastewaters by the removal of suspended matter. The removal is achieved by dissolving air in the wastewater under pressure and then releasing the air at atmospheric pressure in a flotation tank basin. The released air forms tiny bubbles which adhere to the	Metcalf and Eddy, 2004

		suspended matter causing the suspended matter to float to the surface of the water where it may then be removed by a skimming device.	
High rate algae pond	HRAP	HRAPs are shallow raceway reactors in which the mixed liquor, composed by wastewater and a consortium of microalgae and bacteria, flows in a channel around a central wall, driven by a paddlewheel.	Metcalf and Eddy, 2004
Population Equivalent	PE	In wastewater treatment is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time.	Metcalf and Eddy, 2004

Library References

Towards energy neutral microalgae-based wastewater treatment plants

PASSOS, F., GUITIERREZ, R., UGGETTI, E., GARFI, M., GARCIA, J., FERRER, I. (2017): Towards energy neutral microalgae-based wastewater treatment plants. In: Algal Research: Volume 28 , 235–243. **URL (https://www.sciencedirect.com/science/article/pii/S2211926417304629)** [Accessed: 09.07.2021]

Proyecto All-gas Cultivo de microalgas con producción de biocombustibles y eliminación de nutrientes

DE GODOS, I., ZOUHAIR, A., LARA, E., ROGALLA, F. (2013): Proyecto All-gas Cultivo de microalgas con producción de biocombustibles y eliminación de nutrientes. In: RETEMA: **URL (https://www.researchgate.net/publication/279447162_Proyecto_All-gas_Cultivo_de_microalgas_con_produccion_de_biocombustibles_y_eliminacion_de_** [Accessed: 22.07.2021]

Wastewater Engineering. Treatment and Reuse

METCALF AND EDDY McGraw Hill (2004): Wastewater Engineering. Treatment and Reuse. .

Wastewater treatment and algal production in high rate algal ponds with carbon dioxide addition

PARK, J.B.K., CRAGGS, R.J. (2010): Wastewater treatment and algal production in high rate algal ponds with carbon dioxide addition. In: Water Science and Technology: Volume 61 , 633–639. **URL (https://iwaponline.com/wst/article-abstract/doi/10.2166/wst.2010.951/15932/Wastewater-treatment-and-algal-production-in-high?redirectedFrom=fulltext)** [Accessed: 09.07.2021]

High rate algal pond systems for low-energy wastewater treatment, nutrient recovery andenergy production

This paper discusses the design and operation and performance of HRAP systems and their application for economical, low-energy upgrade of conventional wastewater treatment ponds combined with energy recovery and biofuel production.

CRAGGS, R., PARK, J., HEUBECK, S., SUTHERLAND, D. (2014): High rate algal pond systems for low-energy wastewater treatment, nutrient recovery andenergy production. In: New Zealand Journal of Botany: Volume 52 Issue 1, 60-73. **URL (https://www.tandfonline.com/doi/full/10.1080/0028825X.2013.861855)** [Accessed: 09.07.2021]

Further Readings

What are algae

This paper aims to explain 'what are algae' and how to answer the most relevant questions to different players interested in the field, including: academia, industry, trade organizations, consumers, business investors, local and national authorities,international organizations and any other interested party or stakeholder. This position paper represents the position of EABA as the Algae Biomass sector

Association from a European perspective and summarizes information from science, technologyand business dealing with 'algae' biomass, biotechnology and bioproduct.

European Algae Biomass Association (EABA) What are algae. In: European Algae Biomass Association (EABA): **URL (https://www.what-are-algae.com/download.pdf)** [Accessed: 09.07.2021]

High rate algal pond systems for low-energy wastewater treatment, nutrient recovery andenergy production

This paper discusses the design and operation and performance of HRAP systems and their application for economical, low-energy upgrade of conventional wastewater treatment ponds combined with energy recovery and biofuel production.

CRAGGS, R., PARK, J., HEUBECK, S., SUTHERLAND, D. (2014): High rate algal pond systems for low-energy wastewater treatment, nutrient recovery andenergy production. In: New Zealand Journal of Botany: Volume 52 Issue 1, 60-73. **URL (https://www.tandfonline.com/doi/full/10.1080/0028825X.2013.861855)** [Accessed: 09.07.2021]

Comprehensive Evaluation of High-Rate Algal Ponds: Wastewater Treatmentand Biomass Production

In this book chapter, a state-of-the-art review of literature is presented to understand the design, governing process of HRAPs system, and role of different environmental/operational parameters on its performance. Effective implementation of HRAPs system will lead to the production of value-added products like potash in the near future. This chapter may help to frame research work related to improvement/implementation of HRAPs system for effective wastewater treatment and biomass production for fertilizers, feeds, and biofuels.

RANJAN, S., GUPTA, P.K., GUPTA, S.K. Comprehensive Evaluation of High-Rate Algal Ponds: Wastewater Treatmentand Biomass Production. **URL (https://www.researchgate.net/publication/331271591_Comprehensive_Evaluation_Rate_Algal_Ponds_Wastewater_Treatment_and_Biomass_Production)** [Accessed: 09.07.2021]

Important Weblinks

https://incover-project.eu/case-study/case-study-2

This is the webpage of a European project (2020) aiming at reducing the overall operation and maintenance cost of wastewater treatment using wastewater as a source for energy demand and added-value production. Case study 2 was focused on HRAPs for wastewater treatment and biomass production

https://incover-project.eu/case-study/case-study-2 (https://incover-project.eu/case-study/case-study-2) [Accessed: 07.07.2021]

https://www.lga.sa.gov.au/about-lga/what-we-do/community-wastewater-management-systems/high-rate-algal-ponds-hrap

This is the web page of the Local Government Association (LGA) of South Australia. This page provide a description HRAPs, applications, design criteria and case studies.

https://www.lga.sa.gov.au/about-lga/what-we-do/community-wastewater-management-systems/high-rate-algal-ponds-hrap (https://www.lga.sa.gov.au/about-lga/what-we-do/community-wastewater-management-systems/high-rate-algal-ponds-hrap) [Accessed: 07.07.2021]

Video Community Wastewater Reuse with HRAP

This is a presentation about HRAPs experience in Australia made by Howard Fallowfield from Flinders University

https://www.youtube.com/watch?v=DE11Q2fYJJQ (https://www.youtube.com/watch?v=DE11Q2fYJJQ) [Accessed: 07.07.2021]

6.4. Annex 4 Screenshots of PAVITR toolkit Beta Version (Status January 2022)

Deliverable D8.9 **27.01.2022**

In this annex the following screenshots of the PAVITR Toolkit are presented to illustrate the PAVITR toolkit Beta version, status January 2022, embedded in the Sustainable Water and Sanitation Toolbox (sswm.info). Please note that since the toolkit is still under development this Beta version is not publicly accessible, but will only be published once the final toolkit version is available.

Figure 1 PAVITR Toolkit resume page

1 / 2

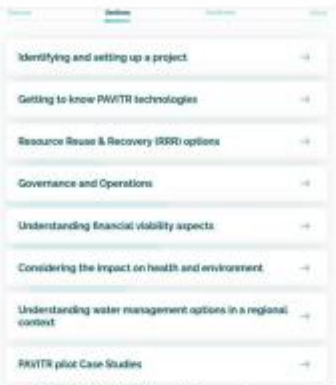

Figure 2 PAVITR Toolkit section overview

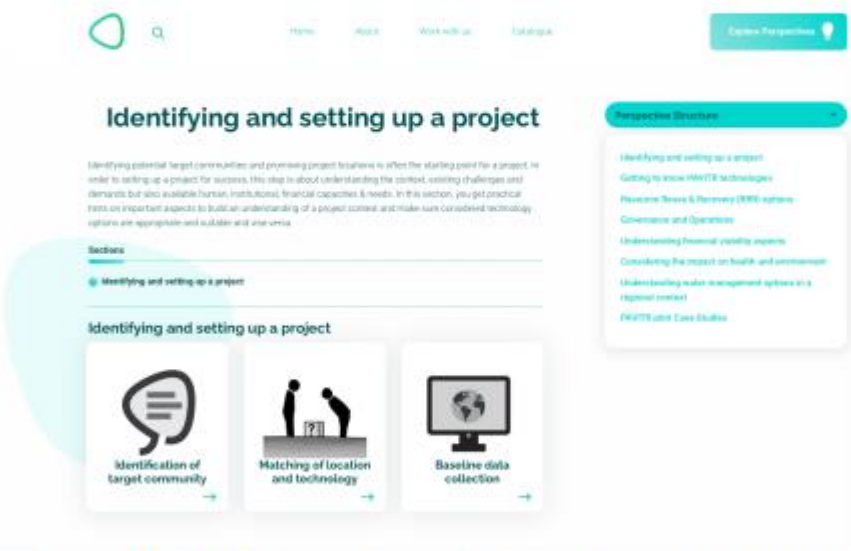

Figure 3 Section landing page showing introduction text and overview of associated factsheet tiles (left) and pull down menu section list (right) – Example with Thematic Layer 1