FLOOD RESILIENT SANITATION SOLUTION FOR RAMANKARY

HACKATHON DOCUMENT - RAMANKARY SANITATION ISSUE

February 2025

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FLOOD RESILIENT SANITATION SOLUTION FOR RAMANKARY

1. Introduction

Kerala Development and Innovation Strategic Council (K-DISC) is the strategic think-tank advisory body of the Government of Kerala, formulating plans reflecting the latest in technology, product and process innovations for the development of the State. It seeks to address the challenges of providing holistic health care, employment, social security, infrastructure, food and nutrition security with a pro-poor bias, gender justice and inclusion of outliers, within severe fiscal constraints.

It runs major coordinated projects with premier international universities and top institutions in various sectors. Some of the prominent projects are Kerala Genome Data Centre, Centre for Excellence in Microbiome, Centre for Excellence in Nutraceuticals, Blockchain Development Project, Electric Vehicle (EV) development & development of alternative energy systems and Skilling Jobseekers & Employability. Four major innovation programmes of KDISC which are closely integrated into Kerala's innovation ecosystem are the following:

1. **One Local Government, One Idea program(OLOI):** The OLOI program aims to address the second-generation developmental challenges faced by Local Self-Government Institutions in Kerala.
2. **One District One Idea Program (ODOI):** ODOI aims to help Micro, Small, and Medium Enterprise Clusters (MSMEs) adopt cutting-edge best practices and unconventional approaches to cluster development that are generally not supported by schemes and programs of the Government of Kerala, Government of India, or financial institutions.
3. **Young Innovators Program (YIP):** A flagship program as part of the innovation segment that aims to empower future innovators to innovate new products, services, or models to meet emerging requirements, unarticulated needs, or existing market needs of society more effectively through specially designed challenges.

4. **Kerala Knowledge Economy Mission (KKEM):** The program has special sub-programmes for Scheduled Castes, Scheduled Tribes, Fisher folk, Transgender and Career Break Women.
5. **Emerging Technology (ET) :** The program is for integrating emerging technologies into government operations.

The pilot phase of the OLOI program focused on addressing 12 distinct problems across 8 thematic areas, which were identified from submissions by 60 Local Self-Government Institutions (LSGIs).

Among these, one significant problem area highlighted was sanitation in water-logged areas. To address this issue:

- Detailed problem canvases were developed through:
    - An in-depth analysis of the existing situation.
    - Understanding the aspirations of the beneficiaries.
    - Defining the scope and boundaries of the problem.
- The process was conducted in collaboration with IIT Bombay and the TAGS Support Forum to ensure robust problem framing.

Floods are one of the most common and devastating natural disasters, affecting millions of people worldwide. One of the critical challenges during and after floods is the collapse of sanitation systems, leading to severe health and environmental risks. To address this, we are organizing a hackathon focused on developing **flood-resilient sanitation systems** preferably **Hub-and-Spoke Model in Ramankary Panchayth**. This hackathon is specifically designed for startups and innovators working in the sanitation sector to propose scalable, sustainable, and flood-resilient solutions.This initiative highlights a collaborative and structured approach to problem-solving, aiming to create impactful and sustainable solutions for pressing local issues.

2. Hackathon Objective

The primary objective of the hackathon is **to design a flood-resilient sanitation system for Ramankary.** Specific objectives include:

1. **Generate Innovative Solutions:** Encourage creative and out-of-the-box ideas to address the challenge of sanitation in water-logged areas.
2. **Enhance Practicality and Feasibility:** Develop solutions that are not only innovative but also practical, scalable, and sustainable in real-world scenarios.
3. **Create Replicable Models:** Develop solutions that can be adapted or replicated in other regions facing similar sanitation challenges.

3.Key Focus Areas

1. **Flood Resilience**: Solutions must be designed to operate during and after flood events and high water table areas, ensuring no disruption to sanitation services.
2. **Hub-and-Spoke Model**: Proposals should incorporate a centralized hub for waste processing and decentralized spokes for collection and treatment.
3. **Sustainability**: Solutions should promote resource recovery (e.g., biogas,sludge reuse, compost, water reuse) and reduce environmental impacts and emissions.
4. **Scalability**: Proposals should be scalable to urban, peri-urban, and rural areas/ in similar biophysical setup.
5. **Affordability**: Solutions should be cost-effective and accessible to low-income communities.
6. **Technology Integration**: Use of IoT, AI, or other technologies for monitoring, maintenance, and optimization is encouraged.

4.Problem Statement

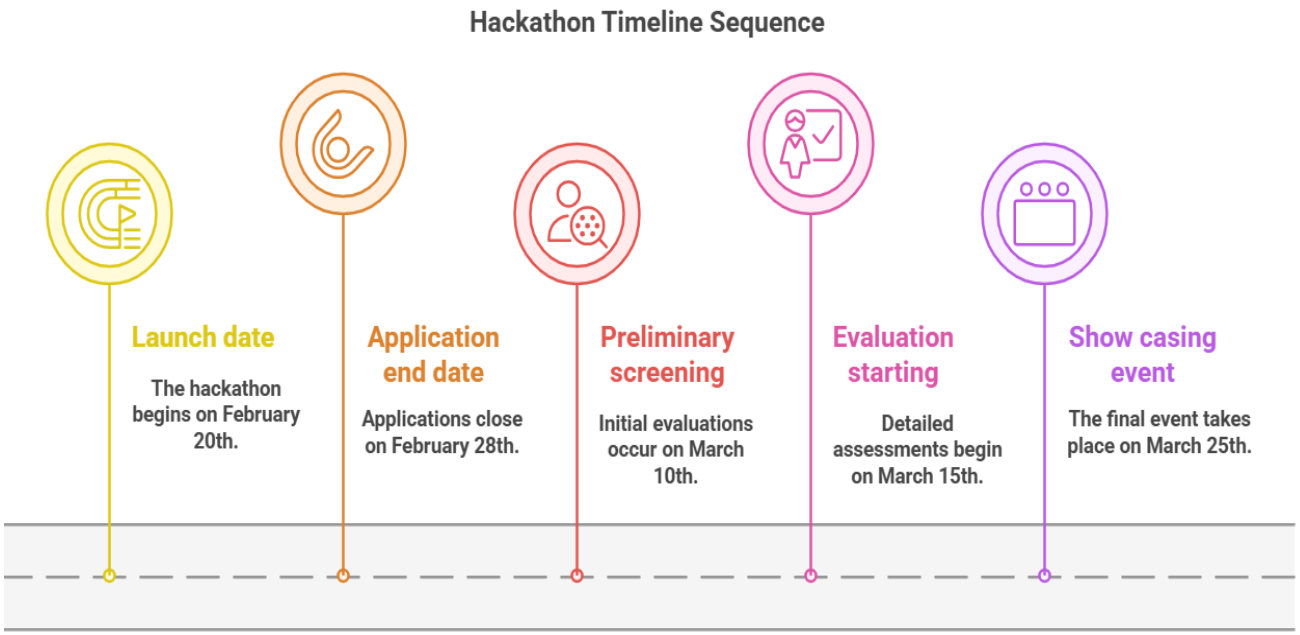
Design a flood-resilient sanitation system for high water table,low lying island like areas using the Hub-and-Spoke Model that:

- Operates effectively during and after the rainy season/floods.
- Ensures safe waste collection, transportation, and processing.
- Promotes resource recovery and reuse.
- Is scalable and adaptable to different geographic and socio-economic contexts.
- Accessible and inclusive design

5.Expected Outcomes

- **Building Innovative solutions :** For flood resilient sanitation systems for high water table areas
- **Business Model:** A sustainable business model for implementation and scaling.
- **Technology Integration:** Use of innovative technologies for monitoring, maintenance, and optimization.
- **Impact Assessment:** A plan for measuring the environmental, social, and economic impact of the solution.

6. Hackathon Timelines



7.Eligibility

- Startups/agencies and innovators working in the sanitation, waste management, or water sectors.
- Teams with expertise in engineering, environmental science, technology, and business development.
- Participants must have a demonstrated interest in solving sanitation challenges.

8. How to Apply

Apply for a hackathon through the designated portal directed by KDISC. Please follow the link https://kdischac.innovatealpha.org/ or visit the official website of KDISC. Once logged in, browse through the document to find the one you're interested in and access detailed information, including the theme, rules, and eligibility criteria.

9. Support Offered

Product/process implementation support with the help of Local Self Government Department (LSGD). Marketing and mentoring support will be given to the selected teams, based on the availability of the same, collaboration with all stakeholders.

10.Indepth Analysis of existing situation (Problem canvas)

Ramankary Panchayat, situated in the low-lying Kuttanad region of Alappuzha district, faces severe sanitation challenges due to frequent flooding and water-logging, which render onsite sanitation systems (OSS) unusable. With no

centralized wastewater treatment system available, the recurring floods exacerbate the issue, posing significant long-term risks.

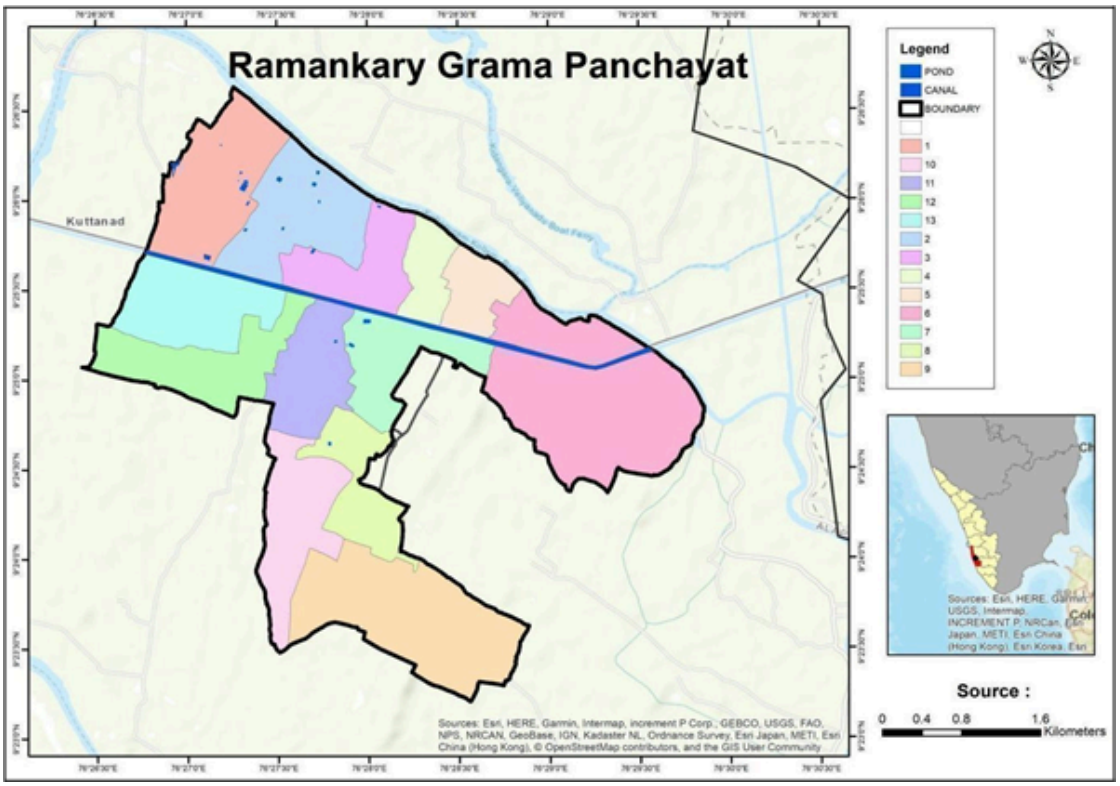


Figure 1 : Map of Ramankary Grama Panchayat highlighting different wards

A study was conducted to assess the area's water and sanitation practices, infrastructure, and services. This report outlines the study's key findings, proposes a solution concept, and presents a detailed plan for a hackathon to address the sanitation challenges in Ramankary Panchayat.Annual inundations, averaging 57.9 cm, worsen the situation for its 4,105 households, 47% of which belong to the BPL category. Farming and daily wage labor are the primary income sources in the region.

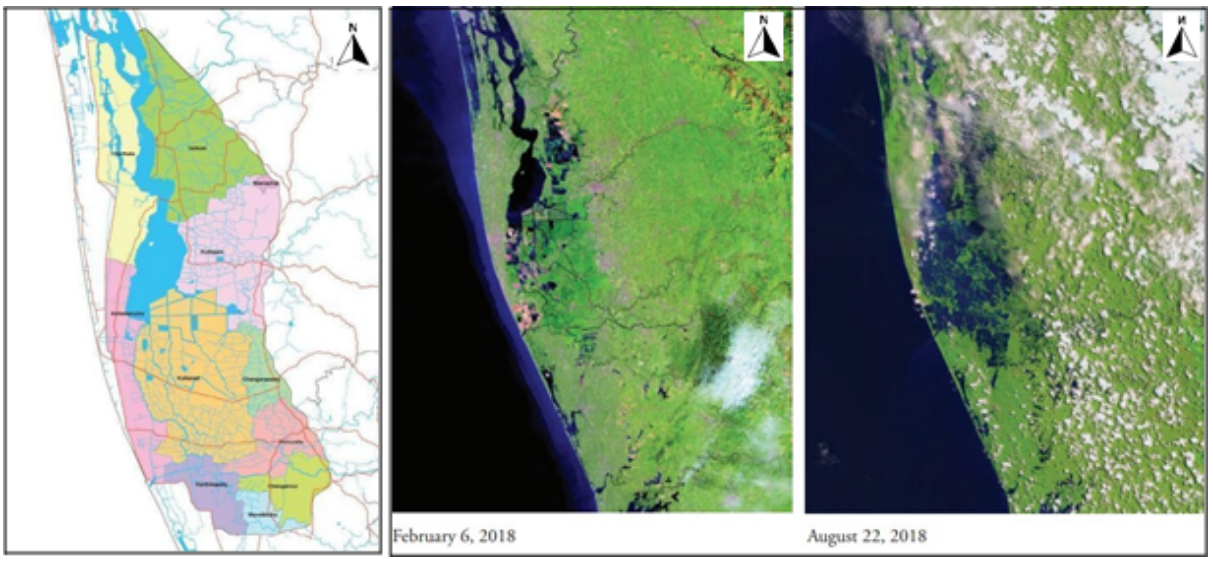


Figure 2a : Map of Kuttanad Region; *Figure 2b :* Satellite images of the Kuttanad region, February 2018 and August 2018 (immediately after flood) (*Source: A Special package for post-flood Kuttanad, Kerala State Planning Board October 2019.*)

Ramankary Panchayat, located 16 km from Vembanad Lake and 13 km from the Arabian Sea, is well-connected by State Highway 11 (Alappuzha-Changanassery Road), which runs alongside the AC canal. The canal diverts floodwaters from upper Kuttanad into rivers leading to Vembanad Lake. The area features scenic paddy fields along the Manimala River and an extensive canal network covering 70% of the land. Its gently sloping plains,and saucer shaped topography, contribute to the region's unique geography.

Figure 3 : Distance Of Ramankary Panchayat From Vembanad Lake and Arabian sea

10.1 Sanitation Infrastructure in Ramankary Panchayat

Sanitation in Ramankary Panchayat varies widely based on flood vulnerability, financial status, and government schemes. Many households use onsite sanitation systems (OSS), including ring-type, rectangular, advanced, and prefabricated septic tanks, each with unique challenges. Lower-income households rely on cost-effective but flood-prone systems, while wealthier households adopt advanced, resilient options. Despite improvements post-2018 floods, many toilets remain vulnerable, especially those with low plinth levels as water logging is a regular phenomenon during monsoon months every year.

Desludging is irregular, with limited access due to narrow roads and no proper faecal sludge treatment facilities. Waste is often dumped in open areas or water bodies, exacerbating environmental hazards. Floods further damage sanitation infrastructure, causing overflow and contamination.

Household wastewater contributes minimally to waterbody pollution compared to untreated sewage, agricultural runoff, and industrial discharges, as highlighted by studies on the Pamba River's pollution during pilgrimage seasons. A basin-level sanitation program with context-specific solutions is essential to address these issues sustainably while mitigating broader environmental impacts.

10.2 Flood Vulnerability Zones

The flood vulnerability in Ramankary Panchayat varies significantly across different regions, impacting sanitation systems and overall community health. Based on flood risk levels, the area has been categorized into three distinct zones: Red, Yellow, and Green. These zones reflect the severity of flooding and its associated risks to sanitation infrastructure, health, and the environment.

1. Red Zone (11.1% of households, Dominant Typologies: 1 & 4)
    - High flood risk with significant health and environmental hazards.
2. Yellow Zone (43.6% of households, Dominant Typologies: 1 & 5)
    - Moderate flood risk with localised waterlogging.
3. Green Zone (45.3% of households)

- Low flood risk, suitable for more conventional OSS solutions.

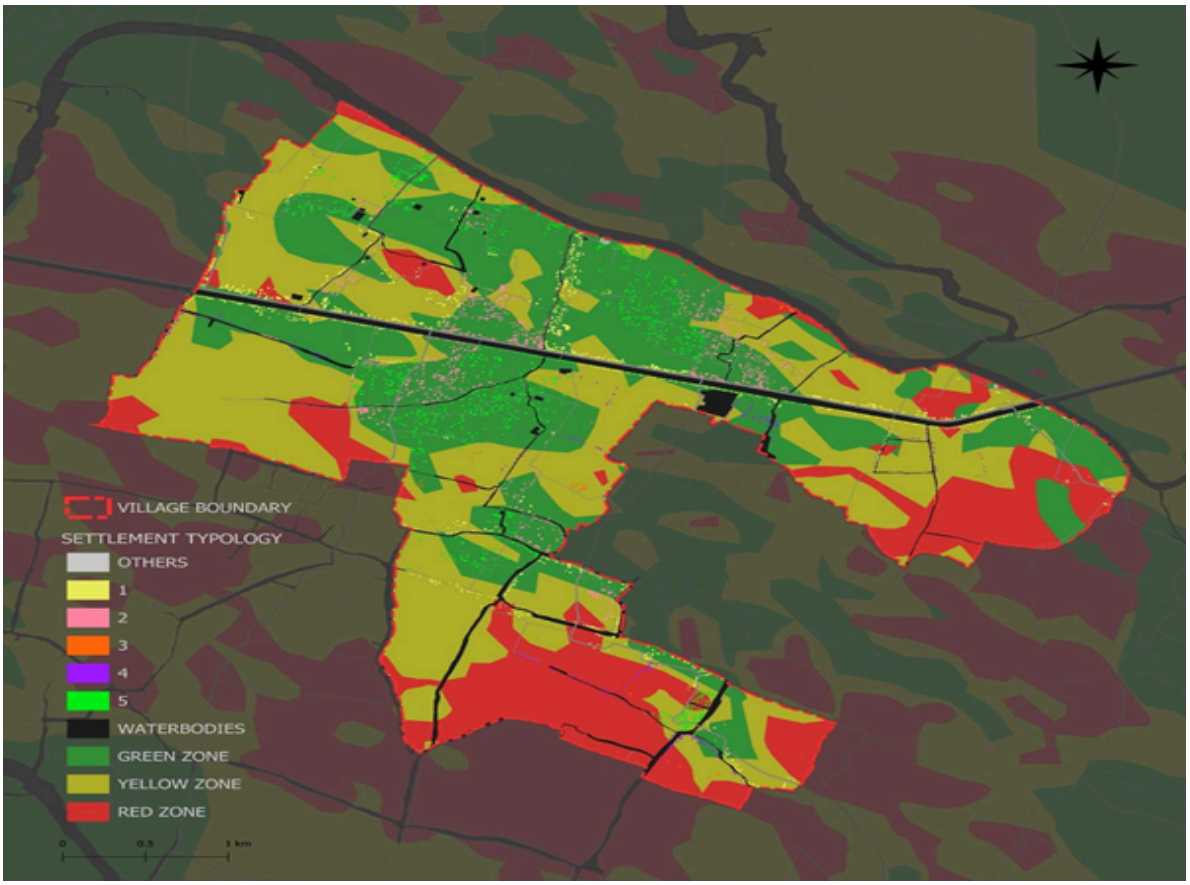


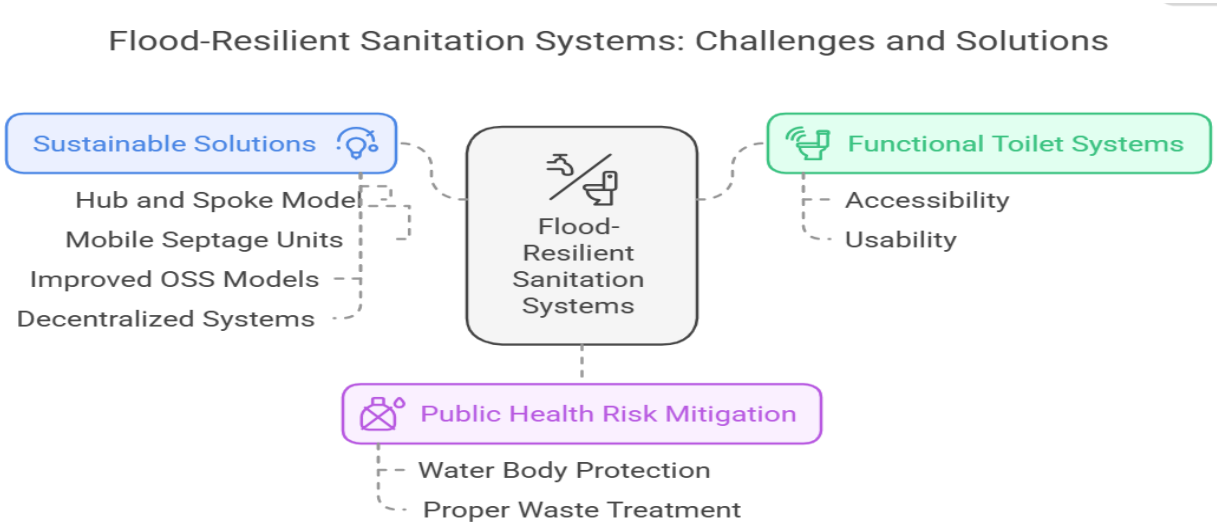
Figure 4: Flood vulnerability zones of Ramankary Grama Panchayat

10.3 Key Issues Identified

1. **Geographical Constraints**:
    - Below-sea-level terrain exacerbates flooding risks.
    - Clayey soils hinder the stability of sanitation infrastructure.
    - A high water table limits the functionality of septic tanks and toilets.
    - Water logging situation prevailing during monsoon months
    - Crisscrossed by rivers and canals landscape is mostly a conjugation of islands,normally hinders normal movement.
2. **Infrastructure Deficiencies**:
    - Poor road access restricts desludging services, leaving septic tanks unmanaged.

- Existing septic tanks are poorly designed, leading to leakage, overflow, and water contamination.
- The nearest treatment facilities are located 80 km away, making secondary treatment impractical.

3. **Flood-Induced Damage**:
   - Toilets become inaccessible during floods, creating widespread public health risks.
   - Septic tanks overflow and contaminate floodwaters, leading to outbreaks of waterborne diseases.
   - Floodwaters frequently damage latrines and other sanitation infrastructure.
4. **Economic Constraints**:
   - The high cost of current toilet designs and on-site sanitation systems (OSS) exceeds government financial assistance.
   - Households struggle to afford resilient systems due to low income levels and limited subsidies.
5. **Inadequate Sanitation Approaches**:
   - **On-Site Sanitation Systems (OSS)**:
     - Septic tanks provide partial treatment but fail to withstand floods, becoming dysfunctional and contaminating water.
     - Liquid waste collection is hindered by accessibility issues, and secondary treatment facilities are unavailable nearby.
   - **Centralized Sewage Systems**:
     - Not proven to be flood-resilient and unsuitable for the area's economic and geographic constraints.
     - Implementing pipelines in a region dominated by crisscross channels, high water tables and frequent flooding poses significant challenges.



- Current sanitation methods—on-site sanitation systems (OSS) and centralized sewage systems—face limitations:

1. **Onsite Sanitation System (OSS):** Septic tanks overflow during floods, contaminate water, and lack secondary treatment facilities nearby, leaving waste untreated and contributing to pollution.
2. **Centralized Systems:** Challenging to implement due to geographic and economic constraints and lack of flood resilience.

The community aspires to affordable, accessible, and flood-resilient toilets and durable, compact septic tank designs. Addressing these issues requires solutions that ensure functional toilets during floods and prevent liquid waste contamination, thereby mitigating public health risks and enhancing long-term resilience.

11.Actionable Insights

1. **Technology Integration**:
    - Advanced materials, IoT-enabled monitoring systems, and resource recovery processes (e.g., composting and biogas production) can enhance sanitation infrastructure resilience.
2. **Policy and Financial Support**:
    - Increased subsidies and government-led initiatives for periodic desludging and infrastructure upgrades are essential.

- Encouraging public-private partnerships to fund localized treatment facilities.

3. **Community Engagement**:
    - Educating residents on the importance of regular desludging and proper waste management.
    - Designing solutions that align with the cultural and economic realities of the community.
4. **Long-Term Planning**:
    - Prioritizing sustainable designs capable of withstanding the area's annual flooding cycles.
    - Mapping high-risk zones for tailored sanitation interventions, including emergency response mechanisms.

5.**Mobile Septage Systems for Treating Faecal Sludge in Flood-Prone Areas :** Flood-prone areas face significant challenges in managing sanitation and faecal sludge due to waterlogging, high water tables, and the failure of traditional sanitation systems during inundation. Mobile septage systems provide a flexible and efficient solution for treating faecal sludge in such areas. These systems are portable, scalable, and capable of operating in remote or disaster-affected regions, offering a critical intervention for improving public health and sanitation during floods.

6.**Hub and Spoke Model for Sanitation Solutions in Water-Logged Areas**

The **Hub and Spoke Model** is an innovative and efficient framework for managing sanitation in water-logged areas, where traditional centralized and decentralized approaches face significant challenges. This model leverages a central "hub" for comprehensive waste treatment and multiple "spokes" for waste collection and initial processing, ensuring effective and scalable sanitation solutions.

Key Components of the Hub and Spoke Model

1. **Central Hub**:
    - A well-equipped facility that acts as the focal point for advanced faecal sludge and wastewater treatment.
    - Located in a strategic, elevated, or accessible area to minimize the risk of flooding and ensure year-round functionality.

    - Processes faecal sludge collected from the spokes into safe by-products such as treated effluent, biogas, and compost.
2. **Spokes**:
    - Smaller, localized units for waste collection, storage, or pre-treatment, such as mobile septage units, transfer stations, or community-level treatment facilities.
    - Spokes are distributed across the water-logged area to provide easy access for households and communities.
3. **Transportation Network**:
    - A robust transportation system to connect the spokes to the hub.
    - Includes vacuum trucks, boats, or pipelines designed to operate in water-logged conditions.
4. **User Interface**:
    - Toilets and septic systems in households and communities that feed into the spokes.
    - Systems are designed to be flood-resilient, with features like elevated platforms and sealed pits.

How the Hub and Spoke Model Works

1. **Waste Collection at the Spokes**:
    - Faecal sludge and wastewater are collected from households or community toilets using vacuum trucks, mobile septage units, or gravity-fed systems.
    - In areas prone to waterlogging, mobile units or transfer stations equipped with storage and basic pre-treatment capabilities act as intermediate collection points.
2. **Transportation to the Hub**:
    - Collected waste is transported from the spokes to the central hub using a reliable and flood-resilient transportation system.
    - The use of boats or amphibious vehicles may be necessary in severely waterlogged areas.
3. **Comprehensive Treatment at the Hub**:
    - At the hub, advanced treatment technologies are employed to process the collected waste into safe effluent and reusable by-products.
    - Techniques include:
        - Anaerobic digestion for biogas production.
        - Composting for nutrient recovery.
        - Effluent filtration for safe discharge or reuse.
4. **Resource Recovery and Reuse**:
    - Treated effluent can be reused for agriculture or aquaculture in the water-logged region.

- Biogas can be distributed for cooking or electricity generation, while compost supports local farming initiatives.

Advantages of the Hub and Spoke Model

1. **Scalability**:
   - Flexible design allows for scaling up or down based on the population and geographical extent of the water-logged area.
2. **Cost-Effectiveness**:
   - Reduces the need for multiple full-scale treatment plants by centralizing advanced treatment at the hub.
   - Optimizes resource use by sharing infrastructure across multiple communities.
3. **Flood Resilience**:
   - Spokes and transportation systems are designed to function in water-logged conditions, ensuring uninterrupted service.
   - The hub is strategically located to remain operational during floods.
4. **Environmental Protection**:
   - Prevents untreated faecal sludge from contaminating water bodies and agricultural fields.
   - Promotes safe disposal and resource recovery.
5. **Community Accessibility**:
   - Distributed spokes ensure that households and communities have nearby access to sanitation services.
   - Reduces the burden of transportation for users.

Challenges and Mitigation

Challenges	**Mitigation Strategies**
Logistical Issues in Flooded Areas	Use boats, amphibious or floating transport systems to ensure connectivity during waterlogging.
High Initial Investment	Secure funding through public-private partnerships (PPPs) or government subsidies.
Community Awareness and Adoption	Conduct awareness programs to educate communities about the model's benefits.

Maintenance and Monitoring	Train local operators and establish regular maintenance schedules for spokes and the hub.
Regulatory Compliance	Develop and enforce standards for effluent quality and sludge management.

Applications of the Hub and Spoke Model

1. **Flood-Prone Rural Areas**:
    - In rural water-logged regions like Kuttanad in Kerala, India, the model can integrate community-level collection systems with a centralized treatment hub located in an elevated area.

2. **Implementation in Mumbai Slums**

- The **hub-and-spoke model** was piloted in **Mumbai's M-East Ward**, where slum residents relied on unsafe, overflowing latrines.
- **Decentralized community toilet blocks** (spokes) were connected via **vacuum pipes** to a **central treatment hub**, reducing contamination and improving hygiene.
- The project led to **a 50% reduction in open defecation and improved sanitation access for 20,000+ residents**.

3. The hub-and-spoke model in Tiruchirappalli demonstrates an effective approach to managing sewage treatment by centralizing resources at a treatment plant while extending service delivery through a network of drainage systems. This model not only enhances sanitation but also contributes to environmental protection by reducing pollution levels in local water bodies.

2. **Urban Slums in Coastal Cities**:
    - In urban slums of flood-prone cities like Jakarta, spokes in densely populated zones can connect to treatment hubs located in less vulnerable zones.
3. **Island Communities**:

- On islands, mobile spokes (e.g., mobile septage units) can serve scattered settlements, transporting waste to a central hub on the main island.

12. Aspirations of the beneficiaries

- **Affordable and Sustainable Solutions:** Community members seek cost-effective, long-lasting sanitation designs using locally sourced materials to reduce maintenance costs.
- **Flexible Toilet Designs:** A desire for both Indian-style squat toilets and Western-style flush toilets to accommodate diverse user preferences, including cultural practices and age groups.
- **Separation of Toilets and Bathrooms:** Advocating for separate toilet and bathing areas to enhance hygiene, reduce contamination risks, and increase convenience for multiple users.
- **Flood-Resilient Infrastructure:** to prevent flooding and groundwater contamination, ensuring safe sanitation during floods.
- **Built with durable and cost-effective materials to withstand flooding:** The toilets are made using flood-resistant and cost-effective materials, to endure prolonged water exposure and reduce damage.
- **Acceptability:** Toilets include user-friendly features catering to the needs of elders, handicapped individuals, children, and pregnant women.
- **Chemical Waste Treatment:** Incorporation of chemicals to accelerate waste breakdown and improve sanitation efficiency, particularly in challenging environmental conditions.
- **Space Optimization:** Proposing toilets adjacent to houses with shared walls to maximize space and improve accessibility.
- **Shared Treatment Systems:** The establishment of communal sanitation systems for multiple households to reduce costs and improve collective sanitation management.
  - **Flood resilient Onsite sanitation systems (OSS):** Onsite sanitation systems should ensure proper containment and treatment of waste, even during flood conditions.
  - **Designed to prevent sinking or floating:** OSS should be designed to prevent sinking due to being overweight and floating during floods.
  - Incorporate measures to **prevent backflow** from OSS into the toilet.
  - Facilitate proper collection of faecal sludge for disposal or treatment.

13. Application Form

Required

1 Name……

2 Phone number……..

3 Email ID……

4 Company/Startup/Agency registered office address

Address……..

Pin……..

District……

State……..

5 Name of Startup/Company/ Agency

Incubator: (if incubated).....

DPILIT Reg No: (Upload registration certificate).....

Legal form of the company/ Startup (Upload certificate of incorporation).....

Proprietorship……

LLP/Partnership……

Pvt Ltd……..

Trust/Society/ Not for Profit……..

Other (Please mention).....

Please share name of all founders along with designation and role

6 Number of founders……..

7 Details of founders……..

Name/Designation……

Equity Percentage……

8 Number of full time team members……

9.Number of part time team members……

10 Problem statement connected to your Innovation/product

Flood resilient sanitation solutions for high water table /low lying/island like areas which,

- Operates effectively during and after the rainy season/floods.
- Ensures safe waste collection, transportation, and processing.

- Promotes resource recovery and reuse.
- Scalable and adaptable to different geographic and socio-economic contexts
- Accessible and inclusive design

(This includes problem solved by your product, specification and its impact)
13 TRL Level (drop down)

a. Basic principles observed……..
b. Technology concept formulated……..
c. Experimental proof of concept…….
d. Technology validated in lab…….
e. Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies).....
1. Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies).....
g. System prototype demonstration in operational environment…….
h. System complete and qualified…….
1. Actual system proven in operational environment (competitive Manufacturing in the case of key enabling technologies……

<<Questions fill above are common for idea stage and prototype stage startups>>

1.Details of pilot demonstration and expert validation

Location/s and details of validation of the pilot……..

2 Status of Patent/s owned by you/company (upload proof)

Granted……
Published……
Applied…….
Not yet applied…….
Not planning to apply……..

3 Details of working prototype…….

Upload photograph/video

4 Expected market price (MRP in INR) and target customers…….

5. Are you currently generating revenues?

Yes/No…….

6. Revenue generated in last FY (2023-24) in INR Mention zero if no revenue is generated…….

7. Competitive advantage of your product (Max 100 words)

(accessibility, affordability, technology etc.)

8 Details of your team structure including employees…….

9 Timeline for solution/product commercialization (Drop down)

Already in Market……

1-6 Months……

7-12 Months…….

13 months and Beyond……

10. Details of Business model and Go to Market Strategy (GTM) (Max 150 words)

<<<Questions specific for prototype stage startups below>>

11. Detalls of funding and award received (Max 100 words) (upload proof)

File upload response…….

12. Please upload a pitch deck. (Must Include the following)

a.Brief description of the product…….

b. Novelty of the product…….

c. Image/design of the product……

d. Technical specifications…….

e. TRL level……

f. Innovation development roadmap with timelines…….

g. Intellectual Property (IP) proof……

h. Certification/ validation report…….

i. Potential market customers or segments…….

j. Expected cost or MRP……

k. Business Model and GTM strategy……..

l. Market competitors……

m. Details of pilot run and its market impact. Mention number of products sold if any……..

n. Funding and award details……

o. Team……..

p. Expected Support……

<<Questions specific for idea stage startups>>

1.Title of the Innovation (Idea).....

2. Short description about the Innovation (Idea) (max 100)

(This includes problem solved by your idea, specification and its impact)

3. Novelty of the idea……

4. How does it solve the problems?.....

5. Timeline for prototype development……

1-6 Months……

7-12 Months……

13 months and Beyond……..

6. Mention your plan for prototyping, productization commercialization……

7.Competitive advantage of your idea (Max 100 words) (accessibility, affordability, technology etc.)

8 Expected market price (MRP in INR) and target customers……

File upload response

Please upload a pitch deck. (Must Include the following).....

a. Brief description of the idea……

b. Novelty……

c. Image/design available……

d. Technical specifications……

e. Innovation development roadmap with timelines……

f. Potential market, customers or segments……