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di Torino**

Department of Architecture  
Master's Degree Programme in Systemic Design

Master's Thesis Developed in Denmark in collaboration with the  
University of Southern Denmark (SDU)

TITLE

**Development of an Accessible Water Drainage System to Support  
Communities Affected by Extreme Weather Events in Denmark**

CANDIDATE

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# ABSTRACT

This thesis investigates how open design can support communities affected by climate change-related flooding through the development of an accessible, low-cost, and community-oriented emergency solution. Starting from the observation of the increasing frequency of extreme weather events, particularly floods and storm surges, the research explores the role of design as a practical tool to strengthen local resilience in non-critical but highly disruptive domestic emergencies.

A multi-level methodology was adopted, integrating several research tools: review of scientific literature and sector-specific books, participation in conferences on the topic, comparative analysis of international case studies on emergency management, netnographic research on online communities affected by flooding, field observations in the Copenhagen area, and qualitative interviews with both young and older residents. This approach enabled the identification of recurring needs, behavioral patterns, and gaps in existing emergency responses, particularly during the early stages of domestic flooding, when institutional intervention is often delayed or absent.

Based on these findings, the thesis develops an emergency pump for rapid domestic water drainage. The device is conceived as a simple system of replicable components, powered by a common electric drill, and employs a hacking design approach to reduce costs, technical complexity, and adoption barriers. The pump was designed to balance functional performance, safety, simplicity, and ease of self-construction using widely available or 3D-printable components.

Beyond the device itself, the project proposes a neighborhood-based service system that transforms the pump into a shared civic infrastructure. Through local workshops, community spaces, and shared access points within residential buildings, the service enables learning, collective use, and long-term maintenance, fostering mutual support and shared responsibility.

Particular attention is given to accessibility, clear visual communication, and the needs of vulnerable users, such as older residents.

The thesis demonstrates that open design, when integrated with service design and community participation, can provide effective and scalable responses to small-scale climate emergencies. By combining technical pragmatism with social infrastructure, the project highlights the potential of design to strengthen local autonomy, reduce vulnerability, and contribute to building resilient urban communities in the context of climate change.

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**PRELIMINARY  
RESEARCH**

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01

# INTRODUCTION

EXTREME CLIMATE EVENTS AND THEIR GROWING IMPACT ON LOCAL COMMUNITIES FRAME THE CONTEXT OF THIS RESEARCH. OPEN DESIGN IS POSITIONED AS A TOOL TO SUPPORT RAPID, ACCESSIBLE, AND COMMUNITY-BASED RESPONSES IN EMERGENCY SITUATIONS.

## 1.1 Research Question

The research underpinning this thesis originates from a central question: how can an open design product support communities affected by climate change related disasters? This question arises from the observation of increasingly frequent events such as storm surges and floods, phenomena that impact territories and populations in ways that are often unpredictable. These events may occur with little warning, making any form of effective preparation difficult, and they tend to unfold suddenly, leaving communities with very limited time to respond. In addition, once water enters a given area, its retreat is often slow and gradual, prolonging exposure to risk for hours or even days.

The consequences extend beyond the immediate emergency and produce long lasting effects. Flood events damage infrastructure, residential buildings, and natural ecosystems, thereby undermining both quality of life and territorial safety. Alongside material damage, such events also generate significant psychological and economic impacts, as residents are required to cope with stress, loss of personal property, and substantial costs associated with recovery processes. Within this complex and fragile context, the research investigates the potential of open design as a support tool capable of providing accessible, adaptable, and shareable solutions in response to climate related emergency situations.

## 1.2 Thesis context and research experience

The process that led to the definition of the topic of this thesis and to the completion of my degree in systemic design began in early 2025. During the winter examination session of the 2024–2025 academic year, I completed the course Design for Components, an experience that represented a significant turning point in my academic path. This course enabled me to engage more consciously with the principles of open design and to understand its practical and social potential. Building on this interest, I selected Fabrizio Valpreda, Associate Professor at the Department of Architecture and Design, as my thesis supervisor, with the aim of developing a project that could integrate design practice, research, and a commitment to contemporary societal challenges.

From the outset, I intended to carry out my thesis research abroad. This opportunity became possible through Tau Lenskjold, Associate Professor at the Department of Design, Media and Educational Science at the University of Southern Denmark, within the SDU Climate Cluster. His research interests, which focus on environmental sustainability in contemporary design, the integration of humanities and participatory design, biodiversity, ecological design, and more-than-human perspectives, provided a fundamental reference framework for both the theoretical and design-oriented approach of this thesis.

The research experience in Denmark proved to be formative in every respect. Denmark, and particularly the city of Copenhagen, offered an open and international environment that enabled meaningful encounters and significant experiences, both on a personal and professional level. The thesis was therefore developed through a shared effort between my supervisor in Italy, Professor Valpreda, through regular remote meetings, and Professor Lenskjold, with whom I was able to engage directly in person. Owing to their guidance,

availability, and continuous dialogue, the research process was undoubtedly challenging yet coherent and well structured, allowing me to grow both as a designer and as a researcher.

## 1.3 Project Objectives and Research Motivations

The choice of this research domain stems from a combination of personal, academic, and context-related motivations linked to current global challenges. On a personal level, there is a strong interest in environmental sustainability and social equity, developed throughout my academic trajectory and reinforced by an increasing awareness of the inequalities that become more evident in times of crisis. Climate change related disasters disproportionately affect the most vulnerable communities, highlighting the need for design approaches that are attentive to both people and places.

From an academic perspective, this research aligns coherently with my background in systemic design and sustainable health, fields that promote an integrated understanding of social, environmental, and productive systems and that position design as a means of generating positive impacts across multiple scales. In addition, the contemporary relevance of the topic represents a central motivation. In the face of the growing frequency and intensity of extreme climate events, it becomes essential to develop inclusive, accessible, and community-driven design solutions capable of addressing urgent and complex challenges.

The objective of the project is therefore to explore how open design can function as a tangible form of support for communities affected by climate related disasters, by providing solutions that are shareable, adaptable to diverse contexts, and capable of strengthening local resilience.

## 1.4 Scope and Focus of the Design Investigation

The scope and focus of the design investigation developed in this thesis are grounded in a theoretical reflection on the nature of climate related disasters and on the ways in which design can contribute to community survival and support during emergency situations. Drawing on the theoretical contributions of De Angelis and on the work *Designing for Survival* (2022) by MD Official, the project is situated within a research trajectory that examines the role of industrial and systemic design in contexts of crisis.

Within this framework, the literature distinguishes between cyclical disasters and wave disasters, as outlined by Bianchini, Bolzan, and Maffei (2021). Cyclical disasters are natural or human-induced phenomena that tend to recur over time following relatively predictable dynamics, such as hurricanes, tornadoes, snowstorms, or heat waves. These events allow, at least to some extent, for forms of advance preparation. Wave disasters, by contrast, are characterised by sudden, or frequently underestimated, flows of adverse climatic, social, and economic phenomena that impact a territory with potentially catastrophic consequences for both people and ecosystems. This category includes events such as droughts, desertification, floods, and sea level rise.

Building on this distinction, the research began with an analysis of the main climate related disasters affecting Denmark, with particular attention to water-related phenomena such as flooding and sea level rise, which represent an increasing threat to coastal communities. This initial investigation made it possible to define the field of design intervention more clearly and to orient the research toward design solutions capable of addressing complex emergency contexts, in which rapid response, adaptability, and community support become central elements.



Photo by Melissa Bradley on Unsplash  
Photo by Mathis Mauprivez on Unsplash

# 02

# RESEARCH OVERVIEW

THE METHODOLOGICAL APPROACH COMBINES SYSTEMIC DESIGN WITH SCIENTIFIC LITERATURE AND AN ANALYSIS OF THE DANISH CONTEXT. THIS FRAMEWORK HIGHLIGHTS KEY CHALLENGES AND DESIGN OPPORTUNITIES RELATED TO FLOOD MANAGEMENT.

## 2.1 Methodology

The methodology adopted in this research is based on the integration of systemic design and product design, interpreted through an open design approach. Systemic design constitutes the primary analytical framework, enabling the identification of critical issues at multiple levels and the observation of relationships among social, environmental, and productive elements within a single system. This approach allows for a comprehensive reading of contexts affected by climate related disasters, highlighting not only immediate problems but also the underlying connections and dynamics that generate and amplify them over time. Within this framework, product design assumes an

operational role, translating systemic analysis into concrete, accessible, and replicable solutions. Open design represents the point of convergence between these two levels, as it promotes shared innovation, reduces waste, and optimises the use of time and resources, all of which are essential factors in emergency situations. Making design processes open and shareable also enables faster responses to crises and facilitates the distribution and adaptation of existing solutions to different local contexts.

In this way, the methodology extends beyond the design of a single artefact and aims to activate synergies within the system, fostering recovery strategies that are more resilient and sustainable, community-driven, and capable of evolving over time.

## 2.2 Scientific literature and key themes

In analysing the scientific literature on disaster management and the resilience of social and natural systems, this research has selected studies that address the topic from multiple perspectives, ranging from systemic approaches to the roles of technology, design, and governance. Afedzie and McEntire (2010), in *Rethinking Disasters by Design*, argue that disasters cannot be understood solely as natural events. They become catastrophes when social, economic, and infrastructural fragilities converge, rendering communities particularly vulnerable. The authors emphasise that disaster prevention and management should be grounded in a conscious design of systems that accounts not only for natural hazards but also for the social and organisational weaknesses that amplify their effects.

Clarke et al. (2022), in *Extreme Weather Impacts of Climate Change: An Attribution Perspective*, highlight how climate change is increasing both the frequency and intensity of extreme weather events, placing significant pressure on territorial systems, infrastructure, and essential services. The authors explain that events commonly perceived as “natural” are in fact intensified

by anthropogenic factors, and that system resilience depends on the capacity to anticipate, adapt to, and respond to these stresses. This perspective helps clarify the interconnection between climatic phenomena and social vulnerabilities, confirming that disaster management cannot be limited to reactive interventions alone.

Izumi et al. (2019), in *Disaster Risk Reduction and Innovations*, explore the role of innovation in risk reduction. Their study shows that new technologies and innovative practices can enhance the effectiveness of preventive measures only when they are integrated within contexts that take local community needs into account. The authors stress the importance of participatory strategies involving citizens, institutions, and non-governmental organisations, demonstrating that innovation in isolation is insufficient without an inclusive social dimension.

Schweizer and Renn (2019), in *Governance of Systemic Risks for Disaster Prevention and Mitigation*, further develop the concept of systemic risks and the need for inclusive governance frameworks to manage them. According to the authors, disasters result from complex interactions among natural, technological,

### PAPER

#### Rethinking Disasters by Design

Richard Afedzie and David A. McEntire  
Department of Public Administration,  
University of North Texas,  
Denton, Texas, USA

Disaster Prevention and  
Management  
Vol. 19 No. 1, 2010  
pp. 48-58

### PAPER

#### Extreme weather impacts of climate change: an attribution perspective

Ben Clarke, Friederike Otto, Rupert  
Stuart-Smith  
and Luke Harrington

Environ. Res.: Climate 1 (2022)  
012001

### PAPER

#### Disaster risk reduction and innovations

Takako Izumi, Rajib Shaw, Riyanti  
Djalante, Mikio Ishiwatari, Takeshi  
Komino

Progress in Disaster Science 2  
(2019) 100033

### PAPER

#### Governance of systemic risks for disaster prevention and mitigation

Pia-Johanna Schweizer and Ortwin  
Renn

Institute for Advanced Sustainability  
Studies eV, Potsdam, Germany  
Vol. 28 No. 6, 2019  
pp. 862-874

and social factors and therefore require integrated policies that involve all system actors, from public institutions and scientific experts to local communities. Systemic governance, as outlined in this study, should be transparent, coordinated, and adaptive, with the aim of reducing vulnerabilities and strengthening overall resilience.

Cappelli et al. (2021), in *The Trap of Climate Change-Induced “Natural” Disasters and Inequality*, show how social inequalities transform climate related disasters into persistent traps for the most vulnerable populations. Their analysis demonstrates that disadvantaged communities experience disproportionately severe impacts and often struggle to recover after emergencies. The study argues that intervention policies must explicitly address these imbalances in order to prevent disasters from reinforcing existing inequalities.

At the same time, literature on design and technology provides relevant contributions. Pietroni et al. (2022), in *A Systemic Approach to Design for Survival*, and De Angelis (2022), in *Survival During Emergencies: The Contribution of Industrial Design*, illustrate how design can play a tangible role in saving lives and enhancing community resilience through the development of

tools, spaces, and solutions capable of responding rapidly to emergency conditions. Both studies, however, emphasise that design is effective only when embedded within a systemic context that integrates technology, scientific knowledge, and inclusive governance. Finally, Di Maio (2019), in *An Open Ontology for Open Source Emergency Response Systems*, proposes open source technological tools for emergency management, demonstrating how shared and collaborative systems can improve coordination and response speed, thereby offering concrete support to community resilience.

The review of these studies clearly indicates that disaster management cannot rely on sector-specific approaches or on reactive measures alone. A systemic perspective is required, one that integrates social, technological, environmental, and political dimensions while promoting inclusive and coordinated strategies of prevention, mitigation, and adaptation. The literature consistently shows that resilient systems can be built only through the interaction of communities, science, technology, and policy, enabling societies to reduce vulnerabilities, protect the most fragile groups, and enhance their capacity to confront extreme and complex events.

*PAPER*

### The trap of climate change-induced “natural” disasters and inequality

Federica Cappelli, Valeria Costantini, Davide Consoli

Global Environmental Change 70 (2021) 102329

*PAPER*

### Un approccio sistemico al design per la sopravvivenza

L. Pietroni, J. Mascitti, D. Galloppo, D. Paciotti, A. Di Stefano

Design for Survival MD Journal 2022

*PAPER*

### La sopravvivenza durante l'emergenza. Il contributo dell'Industrial Design

C. De Angelis

Design for Survival MD Journal 2022

*PAPER*

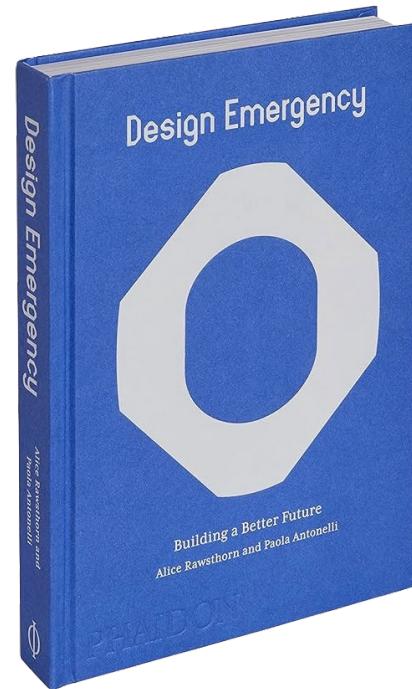
### An Open Ontology for Open Source Emergency Response System

Paola Di Maio  
Mae Fa Luang University, Chiang Rai, Thailand

Vol. 28 No. 6, 2019  
pp. 862-874

## 2.3 Books

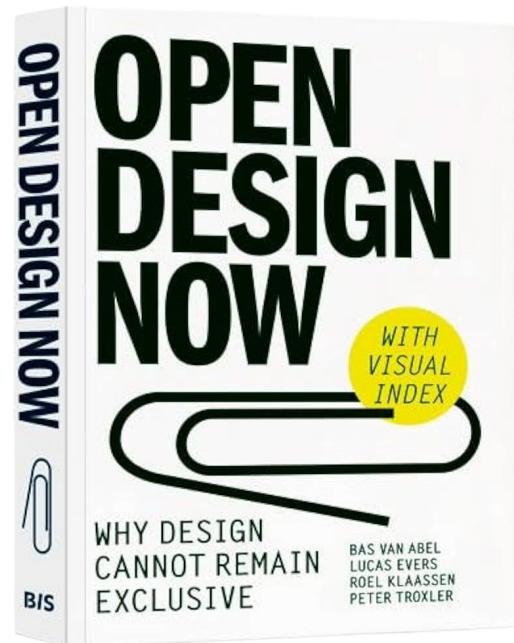
Within the scope of this research, two key books were examined in depth, as they critically address the role of design in crisis management and in the construction of social resilience. The first, *Design Emergency: Design as Resilience and Transformation in Global Crises*, explores how design can operate as a practical tool for addressing complex emergencies, ranging from climate change and pandemics to conflicts and social inequalities. The authors argue that design extends beyond aesthetics and assumes a social and political function, capable of generating immediate and actionable solutions that support people in surviving, adapting, and reconfiguring their living contexts. Through a wide range of case studies, the book demonstrates how design interventions have effectively addressed global crises, emphasising the importance of collaborative and inclusive approaches. In this perspective, dialogue among designers, communities, and institutions emerges as a central element, as resilient tools, systems, and practices can be developed only through cooperation. Design is described as a form of “hope in action”, able to transform conditions of fragility into concrete opportunities, showing how creativity, responsiveness, and practicality can coexist within complex and challenging scenarios.



Design Emergency: Building a Better Future  
Alice Rawsthorn, Paola Antonelli

The second book, *Open Design Now*, focuses on the concept of open and accessible design, positioning itself in opposition to traditional elitist models that restrict participation to a limited group of experts. This approach promotes shared processes, tools, and knowledge, fostering collaborative and participatory solutions. The authors illustrate how digital technologies, such as 3D printing and open source online platforms, enable the democratisation of design and harness the creative potential of communities through effective co-design processes. Open design is presented not only as a technical approach but also as an ethical and political stance, as it supports equity, resilience, and sustainability through inclusive practices that reduce inequalities and actively involve users in the development of tangible solutions. The book highlights the capacity of design to address social and environmental challenges by promoting collaborative innovation and collective responsibility.

Taken together, the analysis of these two texts shows that design can no longer be considered an activity detached from social contexts or emergency situations. Instead, it functions as an active instrument of resilience and transformation. The integration of emergency-oriented, inclusive, and open approaches enables complex problems to be addressed in concrete and participatory ways, reinforcing the importance of combining design practice, collaboration, and technology in the development of communities that are more resilient and better prepared to face future crises.

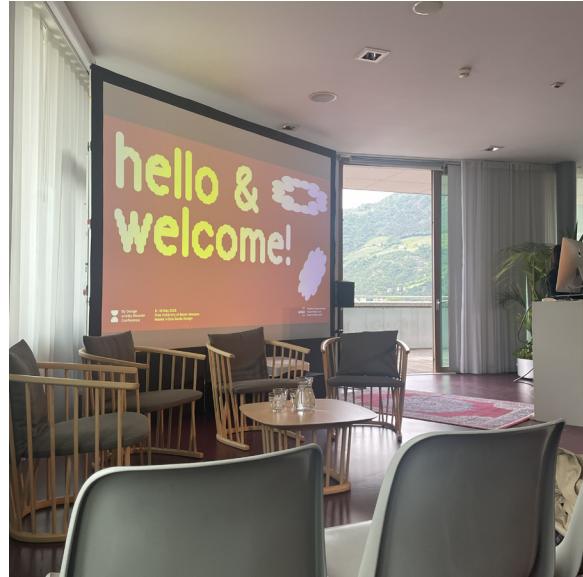


Open Design Now: Why Design Cannot Remain Exclusive  
Andrew Katz

## 2.4 Conferences

During the research process, I had the opportunity to attend in person two international conferences that proved to be highly relevant for deepening my understanding of design for resilience and emergency management.

The first was Design by Disaster, held in Bolzano in June 2025, which included the workshop From Wicked Problems to Prototyping Transitions. This workshop explored methods for translating complex problems into flexible, community-driven design solutions. The experience was particularly valuable for understanding the importance of modular and adaptable tools capable of responding rapidly to crisis scenarios while supporting collaborative decision-making processes. Participation in this workshop allowed me to observe concrete examples of how design can facilitate effective and resilient transitions, encouraging a more practical and inclusive approach to the development of solutions for critical situations.



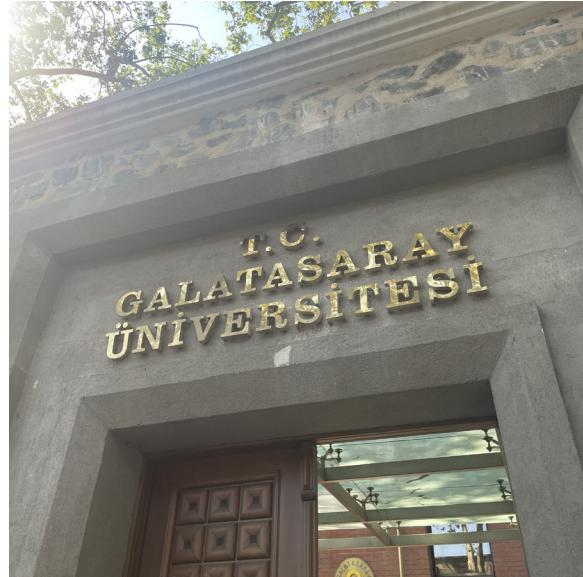
Design by Disaster (Conference)  
June 2025, Bolzano



From Wicked Problems to Prototyping Transitions (Workshop)  
June 2025, Bolzano

The second conference, ICCSA 2025, took place in Istanbul in July 2025 and included the workshop NET-4SAFE – Network for Emergency and Safety Management. This event provided an opportunity to explore the role of digital networks in emergency management. The workshop highlighted how digital platforms can enhance coordination, accessibility, and real-time responsiveness during crises, offering concrete insights into how design artefacts can be connected to existing emergency systems. This experience enriched my understanding of the interaction between design, digital technologies, and safety infrastructures, demonstrating how integrated solutions can be developed through connectivity and collaboration among diverse system actors.

Overall, participation in these two conferences represented a valuable opportunity to bridge theory and practice, examine applied examples of design in emergency contexts, and acquire methodological and technological tools that informed subsequent phases of the project. Both experiences confirmed the necessity for design to be flexible, collaborative, and community-oriented, strengthening my capacity to develop innovative and resilient solutions for complex and evolving scenarios.



ICCSA 2025 – International Conference on Computational Science and Its Applications

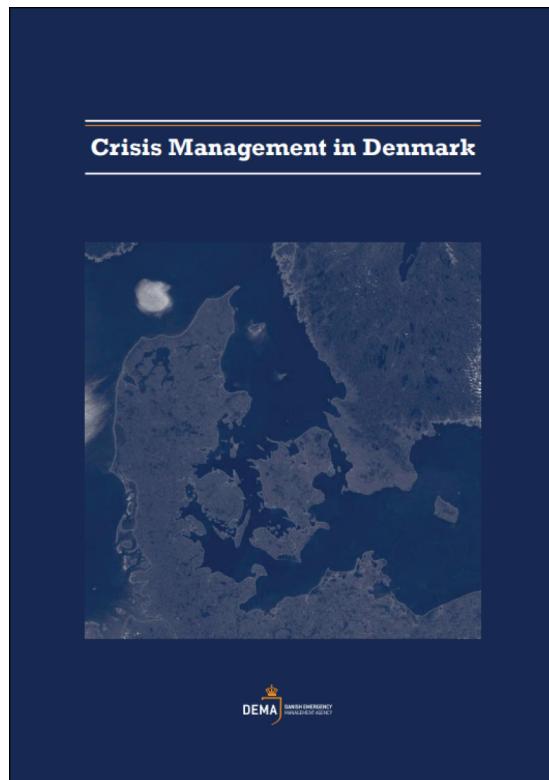


NET4SAFE – Network for Emergency and Safety Management (Workshop)  
July 2025, Istanbul

## 2.5 Emergency Management in Denmark

As this project is developed within the Danish context, it was essential to examine the national emergency management framework, including the institutions involved, the regulatory environment, and the official documents that guide operational procedures and public preparedness. The central authority is the Danish Emergency Management Agency (DEMA), which serves as the country's national civil protection agency. DEMA supports fire and rescue services and local authorities during major emergencies, coordinates national crisis management, responds to CBRN incidents (chemical, biological, radiological, and nuclear), conducts risk analyses, plans emergency preparedness, and organises training programmes and exercises for personnel and institutions. The agency also collaborates with international partners and with the European civil protection system, ensuring coordinated action at both national and transnational levels (DEMA, 2021).

One of the primary reference documents is *Crisis Management in Denmark* (DEMA, January 2021), which provides a detailed account of how Denmark organises and coordinates the management of national crises by defining roles and responsibilities across authorities. The national system is designed to be flexible and cross-sectoral, capable of being activated for any type of emergency, whether natural or human-induced, with the objective of limiting impacts and restoring normal conditions as rapidly as possible. Within this framework, DEMA, operating under the Ministry of Defence, coordinates response efforts, provides technical expertise, and promotes preparedness and national resilience. The agency receives and assesses emergency plans submitted by state authorities in accordance with the Emergency Management Act, Section 24, and oversees activities ranging from national and international assistance to data collection, response strategy development, and public communication management through the DCOK. At the



Crisis Management in Denmark, January 2021

operational level, tools such as NOST ensure up-to-date information and rapid decision-making, while the IOS addresses emergencies involving Danish citizens abroad. On the ground, police forces, health services, and municipal authorities manage direct interventions, ensuring a multi-level and coordinated response while maintaining the specific responsibilities of each actor.

In addition to general emergency management, particular attention was given to Danish strategies for adaptive planning in relation to climate risks. The guide *Guide to Dynamic Planning of Climate Adaptation and Management of the Risk of Flooding in Municipalities* (Danish Coastal Authority, April 2020) outlines how municipalities can apply the Dynamic Adaptive Policy Pathways (DAPP) method to address long-term climate uncertainty by integrating urban planning, coastal protection, and risk management within a flexible and iterative process. The guide introduces analytical tools such as the Source–Pathway–Receptor (SPR) model, used to identify water sources and impacts in urban areas, and the Dynamic Measures Map, which visualises possible combinations of structural and non-structural solutions over time. Concrete applications are provided by municipalities such as Assens and Vejle, which have implemented differentiated flood protection strategies that balance mobile barriers, urban elevation measures, and multifunctional public spaces.

Another key reference is the document *Guide til overvømmelsesdirektivet* issued by the Danish Ministry of the Environment and Equal Opportunities, which describes flood risk management in Denmark. The document explains how the European Union Floods Directive (2007) has been implemented alongside dynamic models such as SFINCS, which simulate realistic flood scenarios over time, and how assessments of social vulnerability complement economic evaluations. Flood management follows a multi-level approach: at the local level, municipalities, police, and fire services manage direct interventions, while in escalating situa-



Guide to Dynamic Planning of Climate Adaptation and Management of the Risk of Flooding in Municipalities, January 2021

tions the Danish Coastal Authority and DEMA become involved. Public communication is centralised, with coordinated alerts, instructions, and evacuations. During emergencies, measures include coastal protection, evacuation of vulnerable areas, and safeguarding of critical infrastructure, supported by continuous monitoring of water levels through sensors, drones, and dynamic modelling. After an event, structural safety checks, restoration of essential services, and psychological and logistical support for affected citizens are carried out, alongside updates to protection plans to strengthen future resilience.

Citizen protection also includes practical guidance on appropriate actions during flood events. Sources such as Beredskab.dk, Aarhus Kommune, Bolius.dk, Naturskaderådet.dk, Tryg.dk, and Greve.dk provide recommendations on household safety measures, damage documentation, personal protective equipment, and cooperation with local authorities, as well as advice on practices to avoid in order to reduce risks related to electricity, contamination, or obstruction of rescue operations. In addition, the DEMA document Be Prepared for a Crisis recommends that each household be capable of self-sufficiency for at least three days by maintaining supplies of water, food, medication, communication tools, and access to payments. This guidance aims to strengthen collective resilience and reduce pressure on public resources during emergencies.

The examination of emergency management in Denmark highlights how an integrated, multi-level system based on flexible tools can address both routine emergencies and complex scenarios such as floods and climate-related crises. The combined action of national agencies, local authorities, operational guidelines, and citizen preparedness measures illustrates a coordinated and participatory approach, providing the regulatory and organisational foundation upon which this project can be effectively and contextually developed.



Guide til oversvømmelsesdirektivet, April 2020

## Prepared for crises

## Checklist

Below is inspiration for a checklist. The checklist consists of suggestions covering most basic needs.

### Drinking water

- 3 litres per person per day
- Water for pets if needed

### Food

- Food for three days with a long shelf life and easy to prepare

### Medicine and first aid

- Necessary medicines for the household
- First aid kit
- Iodine tablets for people under 40 as well as pregnant and breastfeeding women

### Hygiene products

- Toilet paper
- Hand sanitiser
- Nappies, sanitary pads/tampons or anything else relevant to your household

### Heat

- Blankets, duvets, warm clothes

### Other necessities

- Power bank or battery pack for e.g. your mobile phone
- Torch
- Batteries
- Physical payment cards (remember PIN) and cash in coins and small denomination notes
- Candles and matches if needed

### Special needs

- Are there children or elderly people in the household?
- Do you live in a location exposed to e.g. flooding?
- Do you have alternative transport options in the event of flooding, for example?
- Can you help or get help from family, neighbours and friends?

### Communication

- Battery-operated/wind-up/solar-powered FM radio (or your car radio may suffice).

# 03

# CASE STUDIES

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## EUROPEAN CASE STUDIES REVEAL DIFFERENT STRATEGIES FOR WATER MANAGEMENT AND URBAN RESILIENCE. THEIR COMPARISON OFFERS INSIGHTS FOR THE DEVELOPMENT OF ADAPTABLE AND CONTEXT-SPECIFIC SOLUTIONS.

### 3.1 Venice, Italy

Research on case studies was essential for understanding how cities and countries historically exposed to flooding address water-related emergencies, providing concrete examples of prevention, management, and adaptation strategies. The first case examined is Venice, a city internationally recognised for its long-standing exposure to high tides and recurrent flooding. Venice has developed a multi-level approach that combines rapid local actions with large-scale infrastructure, aiming to protect residential buildings, commercial activities, and public spaces while ensuring mobility for residents and visitors.

At the local level, the city employs temporary modular barriers that can be rapidly installed in front of doors and windows during high-water events. These lightweight and reusable structures provide immediate protection for buildings, shops, and public spaces by preventing water intrusion without the need for permanent installations. This system illustrates how simple and flexible solutions can contribute significantly to urban resilience, offering a model that can be replicated in other contexts exposed to water-related emergencies.

Another essential component of the Venetian strategy is the use of electric pumps to drain flooded basemen-

ts and ground floors. These pumps enable the rapid removal of water, limiting damage to buildings and allowing a quicker resumption of economic activities and essential services. Their systematic use represents an effective emergency response measure at the micro scale and complements passive protection measures such as modular barriers.

In addition, Venice deploys temporary elevated walkways during exceptional tides to ensure the continuity of pedestrian circulation. These modular structures provide safe and dry routes for residents and tourists, maintaining accessibility and mobility even under flooded conditions. The walkways exemplify adaptive urban design by combining rapid implementation, safety, and functionality, allowing the city to preserve a degree of normality during extreme events.

Overall, the Venetian case highlights the effectiveness of an integrated and multi-level approach to water emergency management, which combines rapid local interventions with larger-scale infrastructure such as the MOSE system. This system consists of mobile barriers designed to isolate the lagoon from the sea during exceptional tides. The experience of Venice demonstrates how modular, flexible, and coordinated strategies can reduce the impact of flooding, ensure urban continuity, and provide a valuable reference for comparison with other international contexts facing similar challenges.



Flooded street in Venice, Lifegate  
Venice walkways during flooding, Corriere della Sera

### 3.2 The Netherlands

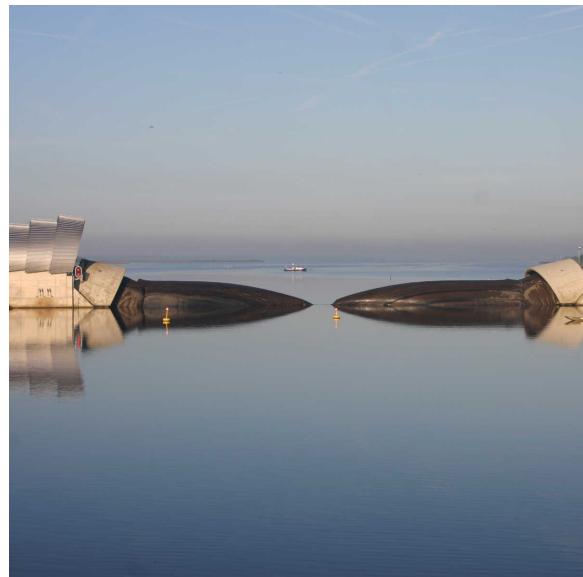
The second case study focuses on The Netherlands, a nation historically vulnerable to flooding, with large portions of its territory located below sea level. The Dutch strategy is characterised by a strong integration of engineering, spatial planning, and ecosystem management, combining targeted local interventions with national-scale infrastructures designed to protect the entire territory. At the local level, solutions include dikes, pumping stations, and adaptive architectural measures developed to ensure both protection and functionality under emergency conditions. At a broader scale, the Delta Works represents a complex network of dams, sluices, and storm surge barriers conceived to safeguard the Dutch coastline from extreme events and storm surges, significantly reducing the risk of catastrophic flooding.

A central element of the Dutch model is represented by the Waterschappen, the regional water authorities responsible for water management. These decentralised bodies coordinate the maintenance of dikes, waterways, and drainage systems, combining technical expertise, citizen participation, and local planning capacity. The Waterschappen illustrate how decentralised governance can enhance efficiency in flood prevention while maintaining continuous dialogue with communities, fostering inclusive practices, and ensuring rapid and effective responses to water-related emergencies.

Among innovative solutions, the Ramspol Inflatable Surge Barrier represents a significant example of flexible infrastructure. This inflatable storm surge barrier protects the IJssel delta and is constructed using rubber membranes that are filled with air during storm events and deflated afterwards. This technology offers a lower-impact alternative to traditional rigid structures, providing protection, flexibility, and environmental sustainability. The adoption of such systems demonstrates how technological innovation can be effecti-

vely integrated into territorial management, combining safety, adaptability, and sensitivity to surrounding ecosystems.

The Dutch experience demonstrates how a combined approach integrating advanced engineering infrastructure, spatial planning, and community participation can substantially reduce flood risk and enhance the resilience of exposed territories. The coordinated management across local and national scales, the active role of the Waterschappen, and the implementation of flexible solutions such as the Ramspol barrier provide concrete and replicable examples of effective strategies for addressing complex water-related emergencies, offering valuable insights for comparison with other European cities and systems.



Ramspol Inflatable Surge Barrier in Kampen

### 3.3 Denmark

The third case study focuses on Denmark, where the management of water-related emergencies and flooding is closely linked to nature-based solutions and community-driven adaptation strategies. At the local level, interventions include coastal dunes, green embankments, and the elevation of buildings, measures designed to protect vulnerable areas while simultaneously reducing environmental impact. These approaches demonstrate that resilience does not need to rely exclusively on rigid infrastructure but can be integrated with the landscape and the natural characteristics of the territory, while also enhancing urban quality and the usability of public spaces.

At a broader scale, Denmark adopts strategies of integrated coastal zone management, combining engineering, landscape design, and urban planning to absorb and redirect water during extreme events. This approach allows for the protection of coastal communities without compromising ecosystems, promoting a flexible and adaptive management of flood risk. The integration of natural and infrastructural elements makes it possible to create resilient systems capable of reducing the immediate impact of high water levels while ensuring safety and continuity for urban and cultural functions.

A concrete example of this philosophy is the perimeter flood protection system implemented at the Viking Ship Museum in Roskilde. In this case, a perimeter flood barrier was designed to integrate seamlessly with the surrounding landscape, providing robust yet unobtrusive protection. This project demonstrates how the safeguarding of cultural heritage can be combined with contemporary resilience-oriented design, ensuring safety without compromising the aesthetic and functional experience of the site. The barrier represents a careful design approach in which architecture, engineering, and environmental management converge to produce effective, sustainable, and replicable

solutions for other vulnerable contexts.

Overall, the Danish experience highlights the importance of nature-based strategies that bring together local interventions, adaptive design, and integrated territorial management. Denmark illustrates how flood protection can be conceived not only as an emergency response but also as an opportunity to enhance urban quality, spatial accessibility, and community resilience, offering a valuable reference for comparison with the cases of Venice and the Netherlands.



Viking Ship Museum in Roskilde

### 3.4 Comparative Synthesis

The analysis of the three case studies – Venice, The Netherlands, and Denmark – reveals key elements that help explain how different contexts address challenges related to storm surges and flooding through a combination of local strategies and larger-scale interventions. The comparative perspective highlights how each country adopts approaches shaped by its geographical, historical, and cultural characteristics, while sharing the common objective of enhancing community resilience and protecting critical infrastructure.

Venice focuses primarily on safeguarding its historic fabric and maintaining a balance between local interventions and the natural dynamics of the lagoon. Modular barriers, elevated walkways, and the use of electric pumps represent rapid and flexible solutions designed to protect buildings, economic activities, and public spaces during exceptional tides. At a broader scale, the MOSE system demonstrates the role of large-scale engineering infrastructure in protecting the city from extreme events, while partially respecting the lagoon ecosystem. The Venetian approach therefore combines temporary measures with permanent infrastructure, highlighting a balance between safety, functionality, and urban continuity.

In the Netherlands, the prevailing approach is based on the principle of “living with water” rather than opposing it. The Dutch strategy integrates local measures such as dikes, pumping stations, and adaptive architecture with national-scale infrastructure such as the Delta Works, while the Waterschappen ensure decentralised and participatory water governance. Flexibility and spatial planning enable the management of extreme events in a sustainable manner, reinforcing the value of local governance and the integration of technological innovation with environmental management.

Denmark places particular emphasis on community

participation and on the aesthetic and functional integration of flood protection measures within urban and cultural contexts. Projects such as the perimeter flood protection at the Viking Ship Museum illustrate how heritage preservation, safety, and landscape harmony can be combined through nature-based and locally adapted solutions.

The comparison shows that, despite addressing similar challenges, the three contexts apply distinct strategies. Venice prioritises the protection of historic heritage through a combination of modular solutions and large-scale infrastructure. The Netherlands adopts a model centred on coexistence with water, supported by spatial planning and systemic resilience. Denmark emphasises local participation and the integration of protective measures within the landscape and urban fabric. These approaches demonstrate how water emergency management can be adapted to local conditions by valuing cultural, environmental, and social specificities.

The synthesis of the three cases provides valuable insights for the development of this project in Denmark, suggesting that the most effective solutions combine flexible interventions, innovative technologies, and active community involvement. The analysis indicates that adaptive and multi-level strategies capable of integrating safety, functionality, and aesthetic quality are essential for building resilient and sustainable systems in flood-prone territories.

# 04

# NETNOGRAPHY

THE OBSERVATION OF ONLINE COMMUNITIES AFFECTED BY FLOODING ENABLES THE IDENTIFICATION OF REAL NEEDS AND INFORMAL EMERGENCY-RESPONSE PRACTICES. VALUES RELATED TO AUTONOMY, SIMPLICITY, AND MUTUAL SUPPORT CLEARLY EMERGE.

#### **4.1 Application of netnography in the research**

As this project is developed within the Danish context, it was essential to examine the national emergency management framework, including the institutions involved, the regulatory environment, and the official documents that guide operational procedures and public preparedness. The central authority is the Danish Emergency Management Agency (DEMA), which serves as the country's national civil protection agency. DEMA supports fire and rescue services and local authorities during major emergencies, coordinates national crisis management, responds to CBRN incidents

(chemical, biological, radiological, and nuclear), conducts risk analyses, plans emergency preparedness, and organises training programmes and exercises for personnel and institutions. The agency also collaborates with international partners and with the European civil protection system, ensuring coordinated action at both national and transnational levels (DEMA, 2021).

One of the primary reference documents is Crisis Management in Denmark (DEMA, January 2021), which provides a detailed account of how Denmark organises and coordinates the management of national crises by defining roles and responsibilities across authorities. The national system is designed to be

flexible and cross-sectoral, capable of being activated for any type of emergency, whether natural or human-induced, with the objective of limiting impacts and restoring normal conditions as rapidly as possible. Within this framework, DEMA, operating under the Ministry of Defence, coordinates response efforts, provides technical expertise, and promotes preparedness and national resilience. The agency receives and assesses emergency plans submitted by state authorities in accordance with the Emergency Management Act, Section 24, and oversees activities ranging from national and international assistance to data collection, response strategy development, and public communication management through the DCOK. At the

## 4.2 Description of the netnographic research

The netnographic research phase involved the collection and analysis of data from online platforms where individuals spontaneously share experiences related to flooding and the management of domestic emergencies. Reddit was selected as the primary data source, as it hosts open discussions and specialised communities in which users freely exchange problems, solutions, and personal strategies. To identify relevant content, specific keywords were used, including “flooded home”, “evacuate flood”, “flood preparation”, and “flood damage cleaning”. These keywords enabled the selection of discussions focused on concrete cases of flood management, as well as on prevention and response practices.

Participants observed in the online conversations primarily included individuals directly affected by flooding, such as homeowners and tenants, alongside home-preparedness and do-it-yourself enthusiasts, local residents, volunteers involved in emergency response, and technical or insurance advisors offering practical guidance. The objective of the research was to identify recurring strategies, shared emotions, and patterns of

collective problem-solving in order to understand how digital communities informally address crisis situations. To obtain a sufficiently robust dataset, five main discussion threads were analysed, with more than 400 comments read and coded. This process made it possible to capture both emotional responses and practical solutions adopted by users, highlighting innovative approaches, recurring behaviours, and forms of mutual support. The analysis also revealed how online communities construct shared knowledge, providing insights that often remain inaccessible through more structured methods such as surveys or formal interviews.

Overall, the netnographic research provided a detailed picture of the lived experiences and response strategies of people exposed to flooding, highlighting practical, adaptive, and often creative solutions. These insights informed the project by offering a grounded understanding of user needs and behaviours, supporting the development of design interventions that are more closely aligned with real-world contexts.

**jnp2346** • 3 mesi fa • Modificato 3 mesi fa

Hmm. Some good advice, some maybe a little premature advice.

I am a fire and water estimator that writes the insurance estimates for mitigation claims, what you're discussing, and restoration estimates for the subsequent rebuild.

The standard flood cut is 4ft now. Provided the water wasn't still present in quantity inside the house for more than 24-48 hours depending on construction.

If you have home insurance, it's best to wait for an adjuster to come out before doing extensive demo, unless(!) they can't get out within 2-5 days. As the insured, you have a responsibility to take measures to prevent extensive damage. I've seen insurance companies use this against homeowners who had no idea about that part of their policy.

Also, use vinegar to spray everything down. It's an outstanding fungicide and bactericide that's also low tox.

Edit, w/heathamae made the excellent point that you have to photo document all damage before work begin as well as progress photos of ongoing demolition that illustrate damage that's initially hidden. For example, wet insulation inside the wall cavity that wasn't apparent until drywall is removed.

51 upvotes, 0 replies, 0 premios, 0 condivisioni

**heathamae** • 3 mesi fa

And please c property has FEMA claim, documentati

20 upvotes, 0 replies, 0 premios, 0 condivisioni

**fairyvegetrader** • 2 mesi fa

Water needs to be extracted ASAP. Call the carpet cleaner, pumps. Number one concern is getting the water out

Next you want to cut open the walls, get dehumidifiers going a lot of that. The number one thing is remove the water an

3 upvotes, 0 replies, 0 premios, 0 condivisioni

**Anal\_Recidivist** • 2 mesi fa • Modificato 2 mesi fa

...why no fema assistance? you need a letter from your ins never sees fema say no at that point.

Do you live on a flood plane/have flood insurance? If not, s letter advising no flood coverage in like a day.

Only scenario I can think of where you wouldnt get assistan insurance to buy the house and then let flood coverage lag

If you didn't do that, we need more context. I'm sure fema saying no happens but I haven't seen it i

7 upvotes, 0 replies, 0 premios, 0 condivisioni

**arasion** • 2 mesi fa

Like the other commenter said, FEMA's been gutted and in recent cases have been actively pre from responding to these sorts of emergencies. It is increasingly up to individual states and loc to respond - from which there is rarely sufficient support.

47 upvotes, 0 replies, 0 premios, 0 condivisioni

**OtterishDreams** • 2 mesi fa

They want to shutter the entire agency in december. If they can drag feet until then they c because it wont exist.

25 upvotes, 0 replies, 0 premios, 0 condivisioni

**Hopeful\_Load\_830 OP** • 2 mesi fa

My county isn't declared a disaster by the POTUS only by the state insurance.The red cross brought me a squeegee and some bed ro have been staying with my in laws cleaning up as it dries

13 upvotes, 0 replies, 0 premios, 0 condivisioni

**Expensive-Ad-1705** • 2 mesi fa

In the aftermath of hurricane ida FEMA helped cover a good basement.Sadly this kind of help is now definitely a thing of thought we were taking there tools.

3 upvotes, 0 replies, 0 premios, 0 condivisioni

**NationalDrag9140 OP** • 3 mesi fa

Yeah good reminder. Tape the handles and sharpie your name all over them bei Your tools will become everyone's the moment they leave your sight.

6 upvotes, 0 replies, 0 premios, 0 condivisioni

**Christmas\_Cactus25** • 3 mesi fa

**commandermd** • 3 mesi fa • Modificato 3 mesi fa

This guy mucks...houses. Timely advice. Thanks for sharing. We had many of these le Houston aftermath.

5 upvotes, 0 replies, 0 premios, 0 condivisioni

**AffectionateIopod59** • 2 anni fa

Flat bottom aluminum John boat. They are not that expensive used. They are easy to paddle and will float in very shallow water.

I'm in Louisiana so flooding is not uncommon. I was careful to pick property that didn't flood. Then when I did my house, it is also 2' off the ground. Also look at where the air intake and alternator is at on your vehicles. We always have people with flooded vehicles from driving in to deep water when we get a lot of rain.

6 upvotes, 0 replies, 0 premios, 0 condivisioni

**Suspicious-Concert12** • 2 anni fa

Why do you say not uncommon instead of common?

1 upvote, 0 replies, 0 premios, 0 condivisioni

**AffectionateIopod59** • 2 anni fa

Same difference. I'm also much better at numbers than I am at English

2 upvotes, 0 replies, 0 premios, 0 condivisioni

**Suspicious-Concert12** • 2 anni fa

I have to ask ChatGPT but it's making sense now. English is my second language.

**r/preppers** • 8 mesi fa [deleted]

## I have to evacuate tomorrow due to flooding. Have my bags loaded and ready, any tips on leaving my house?

Prepping for Doomsday

Do I need to do anything in my house before I leave. I've shut windows, put items up higher, I'm just not able to think clearly.

152 upvotes, 58 replies, 0 premios, 0 condivisioni

**Primary-Ticket4775** • 8 mesi fa

Sandbags, unplug what you can and cover outlets with some type of barrier. Put electrical and other important things up high or take what you can. Prepare to replace some things depending on insurance or lack thereof.

Our home flooded during the Florida storms last year. A kind angel in my local Reddit community group came and brought us so much stuff after the hurricanes (mattresses, tv, couch, lamp, rug, sheets, pillow cases, etc). Things would have been way worse without her kindness.

That said, don't be afraid to reach out and connect with your community. Often times, we're each other's best resource!

4 upvotes, 0 replies, 0 premios, 0 condivisioni

**missmarcello14** • 9 mesi fa

One thing I'll add is please wear boots with puncture protection.

118 upvotes, 0 replies, 0 premios, 0 condivisioni

**NationalDrag9140 OP** • 3 mesi fa

Yep - the more volunteers around you, the less control you have over hazards. For example I thought it was very dumb when I was in Americorps that we had to wear hard-hats and thought "it'll just be extra careful" but then 5 minutes into my first house some kid bonked me on the head with a hammer.

55 upvotes, 0 replies, 0 premios, 0 condivisioni

**[eliminate]** • 3 mesi fa

Wouldn't hurt to be current on your tetanus shot as well

29 upvotes, 0 replies, 0 premios, 0 condivisioni

**APoorEstimate** • 3 mesi fa

And hydrate! I swear to God you're going to get a kidney stone if you don't hydrate. That work is hard as hell

11 upvotes, 0 replies, 0 premios, 0 condivisioni

**[eliminate]** • 3 mesi fa

**cdpas68** • 3 mesi fa

Good call. I volunteered to demo homes after Sandy in NY. A church youth group was taking down walls in the same house as our group and saw something terrible.

I watched a young girl take a crowbar to the forehead being punched through the wall by one of her teen peers. Saw the bone. Be careful.

ags, heavy duty, plastic, etc.  
Clothing, shoes, you name it.

**Old\_Dragonfruit652** • 8 mesi fa

Don't wait until the last minute

**horsesarecool512** • 3 mesi fa

One thing I'll add is please wear boots with puncture protection.

**NationalDrag9140 OP** • 3 mesi fa

Yep - the more volunteers around you, the less control you have over hazards. For example I was very dumb when I was in Americorps that we had to wear hard-hats and thought "I'll just be careful" but then 5 minutes into my first house some kid bonked me on the head with a hammer

**[eliminato]** • 3 mesi fa

Wouldn't hurt to be current on your tetanus shot as well

**APoorEstimate** • 3 mesi fa

And hydrate! I swear to God you're going to get a kidney stone if you don't hydrate is hard as hell

**[eliminato]** • 3 mesi fa

**cdipas68** • 3 mesi fa

Good call. I volunteered to demo homes after Sandy in NY. A church youth group was taking care of the same house as our group and saw something terrible.

I watched a young girl take a crowbar to the forehead being punched through the wall by one

**AsstootObservation** • 3 mesi fa

I was in Houston for Harvey, Memorial Day flood, and tax day flood. They all run together so can't even remember which one it was from, but I remember helping a friend's parent gut their house. We're ripping out Sheetrock and insulation like maniacs. They had just renovated their kitchen and the mom refused to let anyone rip out her new sinks and cabinets. Stressful situation I get it, but acting like a child. In front of everyone I called her out and ask if she wants her and her husband to die of mold. Tell her that all the work everyone has volunteered their time was pointless is we don't fully remediate the house. She wasn't thrilled about it, but came around. Be logical and not emotional about your new kitchen.

**NationalDrag9140 OP** • 3 mesi fa

Yep I've done harvey, deweyville, and the llano floods and i've had pretty much the same experience in each town. Homeowners will definitely be in denial about needing to remove some specific feature in their home and it can become a bad friction point. Kitchens and bathrooms are usually the culprit.

**AsstootObservation** • 3 mesi fa

It's all coming out Barbs, get with the program or leave.

We did manage to carefully carry out the giant slabs of new marble countertops without damage.

**Rich-Criticism1165** • 3 mesi fa

Stay away from popcorn ceiling removal as well as older painted homes. Asbestos and lead are toxic and most of the older homes are full of both of these

**NationalDrag9140 OP** • 3 mesi fa

Yeah if you are in a home older than the 1980's then an N-95 is extra essential because you don't know what another volunteer is doing in another part of the house. You might avoid that asbestos but

**r/preppers** • 2 anni fa

Sea-Bicycle1624

## How to prep for a flood

Hi folks I live in a flood zone. I am wondering what I should do to prepare for that scenario I. (I know step number one is to not buy a house in a flood zone but... what is done is done) anybody have any tips? Also let's keep the budget reasonable here can't afford to drop like 1000s all at once maybe like spend 100 every month or something

Post bloccato. Non è possibile postare nuovi commenti.

**Salt-Operation** • 3 mesi fa

This is all really great information thank you

**Dewert\_Flower2267** • 3 mesi fa

To add to this great post. Make sure if you're taking your own tools to show them to other people. Me and my bro did some volunteer work during the orion creek flood and we were looked at funny because they thought we were taking there tools.

**NationalDrag9140 OP** • 3 mesi fa

Yeah good reminder. Tape the handles and sharpie your name all over them before you even get there. Your tools will become everyone's the moment they leave your sight.

**Christmas\_Cactus25** • 3 mesi fa

**commandermd** • 3 mesi fa • Modificato 3 mesi fa

This guy mucks...houses. Timely advice. Thanks for sharing. We had many of these lessons learned in the Houston aftermath.

**AffectionateIselopod59** • 2 an

Same difference. I'm also much better at numbers than I am at English

**Suspicious-Concert12** • 2 anni fa

Why do you say not uncommo

**Suspicious-Concert12** • 2 anni fa

... home flooded during Uri. Thankfully I wasn't there when they did the tear out. I got what personal items I could salvage and let the company have at it. It was shocking to see my entire first floor torn out but necessary.

... didn't flood. Then when I did... ator is at on your vehicles. We : get a lot of rain.

... second language.

... lords did the work

### 4.3 Key Findings

The netnographic analysis revealed clear patterns in the behaviour of online communities during and after flooding events. Users tend to share first-hand experiences, providing detailed accounts of the actions taken to manage domestic emergencies and recovery processes. A strong culture of mutual support emerges, accompanied by a notable attention to technical accuracy. The tone of the conversations is predominantly pragmatic and supportive, although moments of emotional expression related to stress and uncertainty generated by the events are also present.

The dominant themes identified in the discussions concern immediate actions to be taken following flooding, including personal safety, electricity management, and the use of pumps to remove water. These are followed by activities related to clearing and cleaning homes, drying and restoring interior spaces, preventing mould growth, and managing insurance documentation. At the same time, the conversations reflect the emotional dimension of the experience, highlighting stress, concern, and a strong sense of empathy among users. Recurring statements such as “If it touched water, it must go”, “Take pictures before you touch anything”, and “Fans and pumps are your best friends after a flood” are emblematic, capturing both the pragmatic nature of the responses and the focus on preventing further damage.

Significant shared values also emerge from the observation of these communities, including autonomy in emergency management, collective problem-solving, and the importance of sharing experiences in order to prevent others from repeating mistakes. There is also a clear preference for simple and accessible tools over complex systems or institutional interventions, underscoring the perceived effectiveness of low-tech and easily implementable solutions.

Among the most frequently identified practical solu-

tions in the analysed threads are the use of electric pumps and wet/dry vacuums to rapidly remove standing water, temporary barriers and sandbags to provide additional protection, and industrial fans and dehumidifiers to thoroughly dry walls and floors, thereby preventing mould formation and preserving structural integrity. Despite their simplicity and relatively low cost, these tools represent highly effective immediate responses, capable of limiting material damage and supporting the continuity of everyday activities.

A key insight emerging from the analysis is that users within online communities show a clear preference for do-it-yourself solutions and rapid-response tools over institutional measures or large-scale interventions. This suggests that individuals value the ability to act directly and autonomously, combining community-based mutual support with practical and readily available tools. Consequently, the design of resilient interventions should take into account this inclination towards practicality, immediacy, and ease of use.

05

# PROBLEM IDENTIFICATION

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INDOOR FLOODING IN THE DANISH CONTEXT IS ANALYSED TO DEFINE USERS, VULNERABILITIES, AND NEEDS IN THE IMMEDIATE AFTERMATH OF FLOOD EVENTS. THIS PROCESS ESTABLISHES THE CORE DESIGN PROBLEM.

### **5.1 Storm surges and flooding phenomena in Denmark**

To understand the Danish context in relation to water-related emergencies and storm surges, it is necessary to consider both climate change dynamics and the country's social and infrastructural structure. Over recent decades, average temperatures in Denmark have increased by approximately 1.5 °C compared to 1873, accompanied by an increase in precipitation of around 15%. These trends have resulted in more intense and frequent rainfall events, placing growing pressure on urban systems and existing infrastructure. According to data from PreventionWeb and the Tech-

nical University of Denmark (DTU), the current annual costs associated with flooding caused by cloudbursts and storm surges amount to approximately 7 billion Danish kroner. In the absence of adequate adaptation measures, these costs could rise to 27 billion kroner per year by 2100. Long-term analyses estimate that, without mitigation interventions, cumulative damages over the next century could reach approximately 406 billion kroner, affecting residential buildings, commercial activities, and agricultural land.

National flood risk assessments have identified 51 out of 98 municipalities as being at significant risk, both along coastal areas and inland, highlighting the

widespread nature of the issue. Projections related to sea level rise indicate that by 2120 approximately 72,700 hectares of Danish coastline could be permanently submerged, while by 2070 the area exposed to permanent risk is estimated at around 18,100 hectares. Coastal wetlands are also expected to be severely affected, with approximately 45% (199 km<sup>2</sup>) subject to permanent inundation. Agricultural areas, amounting to roughly 191,000 hectares, are projected to experience frequent marine flooding during extreme events. In the capital city of Copenhagen, estimates suggest that around 500,000 buildings and dwellings could be exposed to flood risk over the next fifty years if sea level rise and storm surges intensify. A notable example is the event of 2 July 2011, when an exceptional cloudburst delivered approximately 135.4 mm of rainfall in a single day at the Copenhagen Botanical Garden, causing damages estimated at around 6.2 billion Danish kroner.



Flooding in Denmark, TV 2 Kosmopol

Despite the severity of these risks, Denmark is a wealthy and highly developed country, characterised by robust infrastructure, effective emergency systems, and strong governance. Copenhagen, in particular, benefits from a high level of public awareness regarding climate risks and flood preparedness, as well as access to experts, research institutions, and well-established local knowledge. This context makes the city an especially suitable environment for testing innovative design solutions for emergency management, offering valuable insights into how communities can be engaged, existing infrastructure integrated, and scalable interventions developed that could later be adapted to more vulnerable territories.

Denmark therefore presents a complex scenario in which significant risks related to storm surges, extreme rainfall, and sea level rise coexist with substantial material resources, technical expertise, and effective governance structures. This balance between natural vulnerability and response capacity positions Copenhagen as a representative case for the development of effective and participatory design solutions capable of addressing the challenges posed by climate change.

## 5.2 Case study: storm surge event in Kerteminde (2025)

The case study of Kerteminde, a Danish coastal town, provides a concrete example of how local communities respond to storm surge emergencies when public solutions are perceived as insufficient or delayed. Each year, during the storm surge season, the town experiences flooding events that affect residential buildings, public spaces, and infrastructure, causing significant damage to basements, outdoor furnishings, and the urban fabric more broadly. In 2025, following repeated flooding episodes and slow progress in state-level planning, 65 households decided to take autonomous action by creating a collective fund of

7,500 Danish kroner per family. With this budget, a 425-metre-long modular barrier composed of 700 assemblable elements was constructed to protect homes closest to the harbour from future storm surges. The total cost of the intervention amounted to approximately 400,000 Danish kroner (Danmarks Radio, 2025).

The initiative undertaken by the residents of Kerteminde clearly illustrates how, in high-risk contexts, communities are often compelled to assume responsibility for their own protection, highlighting a bottom-up approach to risk management. However, as emphasised by Kirsten Halsnæs, professor at the Technical University of Denmark (DTU), such actions, while understandable and pragmatic, should not rest solely on private individuals. Storm surges do not affect only individual dwellings but the entire community, including public buildings, churches, roads, schools, and parks. Estimates from DTU indicate that only around 40% of the costs associated with storm surge protection can be attributed to private property, reinforcing the argument that responsibility for mitigation should be shared with local authorities and the state (Halsnæs, cited in Danmarks Radio, 2025).

In response to growing risks, the Danish government has recently proposed an acceleration package of 900 million Danish kroner aimed at rapidly advancing coastal protection projects. However, the definition of funding mechanisms and their allocation remains under negotiation among political parties in the Folketing. In the interim, local administrations and citizens have initiated preparatory work to ensure that, once funding becomes available, technical solutions can be implemented without further delays. Professor Halsnæs notes that timelines remain critical given the proximity of upcoming storm surge seasons and stresses the need for swift state intervention to complement local efforts, particularly for complex projects such as dikes and floodgates that protect extensive urban areas and critical infrastructure.



Storm Surge Event in Kerteminde (2025), DR.DK

From a climate disaster research perspective, this case highlights several relevant aspects. First, it demonstrates how communities can develop collaborative and innovative solutions under urgent conditions, reflecting patterns identified in the netnographic research, where autonomy, experience sharing, and the use of simple and immediate tools emerge as core values. At the same time, the case underscores the importance of an integrated and multi-level approach in which local actions are supported by national governance, public resources, and strategic planning, ensuring that protection measures are effective not only for individual households but for the community as a whole. Kerteminde therefore represents a tangible example of how citizen participation can accelerate the adoption of adaptation measures, offering valuable insights for the design of resilient, flexible, modular, and replicable solutions applicable to other vulnerable coastal contexts.



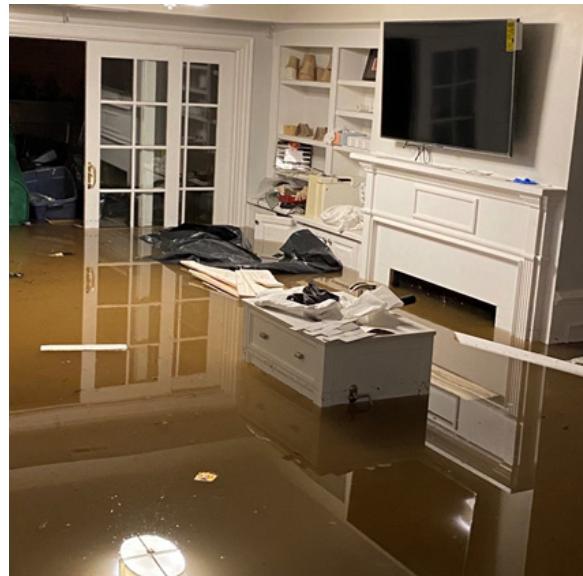
Storm Surge Event in Kerteminde (2025), DR,DK

### 5.3 Outdoor and indoor flooding

Flooding in urban contexts produces distinct effects depending on whether it affects outdoor spaces or indoor environments. In outdoor settings, streets, squares, and parks experience disruptions to mobility, as floodwaters can render the movement of vehicles and pedestrians impossible and may damage public infrastructure such as pavements, lighting systems, sewer networks, and drainage facilities. Green areas and recreational spaces may be submerged, temporarily limiting public use and causing soil erosion or damage to vegetation. Accumulated water can also transport debris, waste, and pollutants, increasing health risks and necessitating cleaning and sanitation operations.

In indoor environments, such as apartments and residential buildings, flooding results in immediate and often long-lasting damage. Water may infiltrate ground floors or basements, affecting flooring, walls, electrical systems, and furniture. The presence of standing water promotes mould growth and bacterial proliferation, compromising indoor air quality and requiring extensive drying and remediation interventions. The impacts also extend to personal belongings and electronic equipment, which are frequently irreparably damaged. Beyond material losses, indoor flooding generates stress, anxiety, and discomfort for residents, who must cope with both the loss of property and the logistical challenges associated with restoring normal living conditions.

Flooding in outdoor environments primarily disrupts urban functionality and threatens public infrastructure and shared spaces, while indoor flooding directly affects dwellings, leading to material damage, safety concerns, and emotional distress for occupants. Both scenarios call for specific, integrated, and timely strategies of prevention and intervention, tailored to the characteristics and vulnerabilities of each context.



Flooding in Denmark, Climate Reality Project

## 5.4 Site visits: Copenhagen area

Copenhagen represents a key case study in the analysis of urban resilience to flooding and storm surges, owing to its integrated approach that combines architecture, urban design, and water management. The city has developed design strategies capable of absorbing and redirecting both rainwater and storm surge flows, transforming public spaces into active components of civil protection. Architecture and the urban landscape are conceived not only to withstand extreme events, but also to adapt flexibly, combining everyday functionality with safety during emergencies.

During the field visits, several emblematic interventions were observed. At Kalvebod Brygge, the waterfront park functions simultaneously as a public space and as a flood protection system. Green areas and permeable surfaces are designed to absorb water during storm surges, while maintaining pedestrian routes and recreational zones that remain usable under normal conditions.

At Enghaveparken, a large underground retention basin is integrated beneath the park, enabling the storage of excess water during extreme rainfall events. The surrounding green areas further contribute to water absorption, while the overall design addresses the management of exceptional precipitation, ensuring that the public space remains functional for daily use while serving as an effective tool for urban resilience.

At Erik Ballings Vej 4C, residential buildings are designed with elevated ground floors and a surrounding landscape specifically shaped to absorb water. Local infrastructure is prepared to manage potential flooding, illustrating how the integration of residential architecture and drainage systems can significantly reduce damage and facilitate post-event recovery.

Finally, at Tåsinge Plads, rain gardens have been implemented to filter and retain stormwater within a

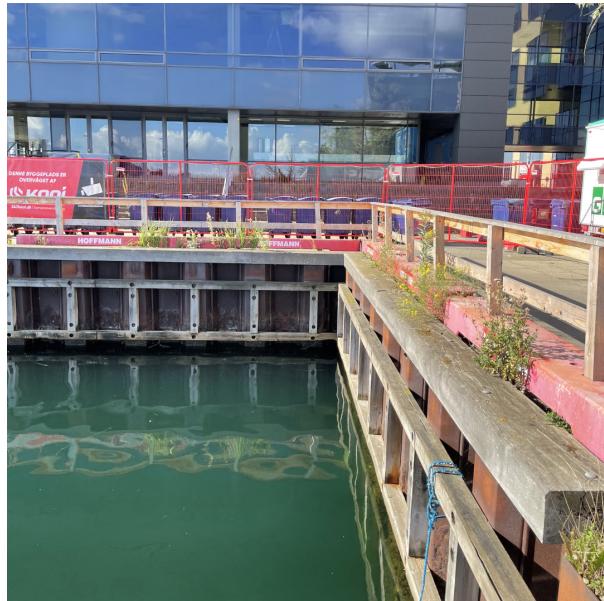
multifunctional urban square. This design approach creates attractive and accessible public spaces for the community, while excess water is managed in a natural and safe manner, turning a potential hazard into an opportunity for participatory and inclusive design.

These field visits provided direct insight into Copenhagen's capacity to embed resilience solutions within urban spaces, demonstrating how architecture, landscape, and infrastructure can work together to reduce flood risk and enhance public safety without compromising everyday urban life. The on-site observations confirmed the effectiveness of flexible, multifunctional, and community-oriented approaches, offering valuable inspiration for the resilient design project developed within this research context.



Nyhavn, photo by Agnese Baldoni

# Kalvebod Brygge





⏴ Waterfront park doubling as flood protection

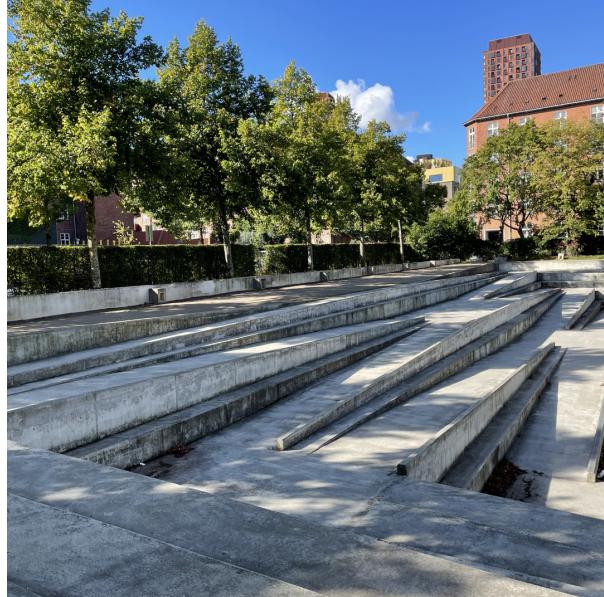
⏴ Flexible public space



⏴ Absorbs stormwater during surges

# Enghaveparken





⏴ Large retention basin  
under the park

⏴ Green areas for water  
absorption

# Erik Ballings Vej





- ⏴ Elevated ground floor design
- ⏴ Water-absorbing landscape

# Tåsinge Plads





☑ Rain gardens filtering water

☑ Multifunctional urban square



☑ Community-focused resilience

## 5.5 Key characteristics of the analysed problem

Flooding does not affect only streets and public spaces but directly impacts the interior environments of residential buildings, where consequences can arise rapidly and with significant intensity. Water may enter dwellings through doors, windows, or ground-level access points, and even a few centimetres can cause substantial damage to furniture, flooring, and personal belongings. Indoor flooding also poses immediate safety risks for occupants, including slips, short circuits, and hazards related to electrical systems, in addition to the potential development of mould and bacteria.

This type of flooding presents specific characteristics that make its management more complex than in outdoor environments. Furniture, particularly wooden items or those with fabric coverings, may warp, stain, or deteriorate when exposed to water. Drying times for floors and walls are often prolonged, delaying the return to normal living conditions and complicating cleaning and restoration operations. Moving heavy furniture to prevent further damage can be physically demanding and time-consuming, increasing stress levels during emergency situations. Beyond material damage, indoor flooding entails health risks, as standing water encourages the growth of mould and bacteria, with potential long-term effects on residents' respiratory health. The emotional and economic consequences are also significant, as residents must cope with the loss of possessions, the costs of repairs and replacements, and the disruption of everyday activities.

Indoor flooding therefore constitutes a complex and multidimensional problem in which material damage, health risks, and emotional impacts are closely interconnected. Addressing this issue requires rapid interventions, targeted prevention strategies, and resilient solutions capable of reducing exposure and facilitating recovery.

## 5.6 Definition of the target group

The design project is conceived for a specific target group of young individuals who are aware of social and climate-related issues and are interested in actively contributing to the resilience of communities affected by flooding and natural disasters. This group primarily includes people between 16 and 30 years of age, living in urban or semi-urban areas exposed to flood risk. They generally demonstrate a solid awareness of environmental and social challenges and are often secondary school or university students, with low to medium income levels and limited financial resources for purchasing specialised emergency kits.

From a psychographic perspective, these individuals are motivated by a strong sense of social responsibility and a desire to support their local communities. They value collaboration, co-design, and open-source solutions, and they seek intuitive, modular, and easy-to-use tools that enable immediate action during emergency situations. They are interested in learning and in actively participating in prevention and risk management activities, sharing knowledge and practices with peers and with the wider community.

From a behavioural standpoint, this target group is inclined towards volunteering and is willing to assist neighbours and local residents during emergency events. They frequently use mobile phones, social media, and online platforms to access information and practical guidance, and they prefer solutions that do not require prior technical expertise. Their ability to act quickly during the initial phases of a flood is a key factor, as is their preference for tools that are portable, accessible, affordable, and easy to deploy.

Overall, the target group requires design solutions that are flexible, modular, and collaborative, supported by clear instructions and minimal learning time. The objective is to provide practical tools that can be used immediately during flooding events, not only to protect

homes and reduce damage, but also to encourage active participation and strengthen community ties, recognising young people as key actors in urban resilience.

## 5.7 Emerging needs in the post-flood phase

The analysis of post-flood needs shows that affected individuals face a range of immediate and practical challenges, both outdoors and within their homes. During flooding events, one of the primary needs concerns the availability of reliable lighting. Visibility is essential for moving safely during prolonged power outages or extreme weather conditions, enabling timely action and reducing the risk of accidents.

At the same time, immediate access to emergency tools is crucial, including first aid kits, basic equipment, and clear guidance on how to act effectively and safely. Rapid intervention during the initial critical hours can significantly influence personal safety and help limit material damage. In water-related emergency situations, there is also a need for simple and safe solutions that allow people to assist others who may be trapped, without requiring professional training or specialised skills.

Mobility and ease of use represent another central requirement. Tools must be easily transportable, usable in different contexts, and immediately operational without the need for specific technical knowledge. Overall, the target group requires affordable, accessible, modular, and collaborative solutions that can be deployed quickly and that encourage cooperation among neighbours and community members.

When flooding affects indoor environments, needs become even more specific. Even limited water levels can damage furniture, flooring, and personal belongings. Residents require tools that enable them to protect

and elevate furniture, reduce water infiltration, and act promptly to limit structural damage and mould formation. Timely response is critical, as water can rapidly penetrate floors and walls, making drying and cleaning operations more complex and delaying recovery. Tools should be intuitive and manageable by a single person, allowing effective and safe intervention without reliance on external assistance.

Emerging post-flood needs therefore revolve around safety, speed of action, practicality, flexibility, and accessibility. Design solutions should address these requirements by supporting residents in protecting domestic environments while also fostering collaborative actions at the community level.

# What citizens **should do if** their home is flooded?

- ⏴ Ensure that the electrical system is turned off before entering flooded rooms to avoid the risk of electric shock.
- ⏴ Document the damage with photos and videos (water in rooms, furniture, systems) in preparation for contacting your insurance company or the authorities.
- ⏴ Wear appropriate protective gear (gloves, waterproof boots) if entering areas with water that may be contaminated.
- ⏴ Remove water and debris as soon as possible, dry and ventilate the rooms to prevent mould and secondary damage.
- ⏴ Check/contact water, sewerage and sanitary systems: flood water may be contaminated or may flow back from drains.
- ⏴ Cooperate with local authorities and services: follow any evacuation orders or restrictions.
- ⏴ Protect essential items by raising them or moving them from flooded areas (especially if on the ground floor).

# What citizens **should not do** if their home is flooded?

- ⚠ Do not enter flooded premises until you are sure that the electrical system is turned off and the structure is stable.
- ⚠ Do not use electrical appliances that have been submerged or operated in wet environments: electrical risk and invalidation of warranties or insurance policies.
- ⚠ Do not ignore damage documentation: disposing of everything immediately without recording it may compromise compensation.
- ⚠ Do not treat standing water as if it were harmless: it may contain pathogens or sewage.
- ⚠ Do not undertake complex rescue operations on your own if you do not have the necessary skills (e.g. removing barriers, major drainage), as you could hinder rescue efforts or make the situation worse.
- ⚠ Do not spread inaccurate or sensational information on social media channels that could cause confusion or panic.
- ⚠ Do not underestimate the situation: even if the water seems to be slowing down, the structure or systems may be compromised.

## Sources

Beredskab.dk – official advice from the Civil Protection Agency. Aarhus Kommune – what to do before, during and after a flood. Bolius.dk – home protection and backflow prevention systems. Naturskaderådet.dk – compensation for natural damage. Tryg.dk – insurance and prevention guide. Greve.dk – practical local advice in case of flooding.

# 06

# CONCEPT DEVELOPMENT

THE EXPLORATION OF MULTIPLE DESIGN CONCEPTS HIGHLIGHTS THE NEED FOR SIMPLE AND IMMEDIATE SOLUTIONS. THIS PROCESS LEADS TO THE SELECTION OF THE DRAINAGE PUMP AS THE MAIN DESIGN RESPONSE.

### **6.1 Overview of conceptual proposals**

Before arriving at the final concept, several design directions were explored in order to identify the solution most capable of addressing the needs associated with flood emergencies. During this phase, three main proposals were analysed: a multifunctional lamp designed to provide lighting, support rescue activities, and offer access to essential tools; furniture elevation systems intended to protect household items from water during flooding events; and an open design pump aimed at rapidly draining water prior to the arrival of emergency services.

The objective of this exploration was to assess the strengths and limitations of each concept by comparing complex, multifunctional solutions with simpler and more practical alternatives. This process made it possible to identify which elements were genuinely useful in emergency situations and which, by increasing complexity, could hinder usability and effectiveness under conditions of stress and time pressure.

## 6.2 Concept 1: Multifunctional Lamp

The first concept explored was a multifunctional lamp designed to respond to flood emergencies by integrating multiple functions into a single object. The idea was to develop a device capable of providing lighting, supporting rescue activities, and offering immediate access to essential items such as first aid kits or basic hygiene supplies, thereby facilitating intervention by untrained young volunteers. The lamp was conceived with a detachable light module, integrated handles, and a base containing emergency materials.

Among the most compelling aspects of this concept was its potential to enhance volunteer autonomy and encourage coordinated community responses, as well as the possibility of producing it through participatory workshops. However, several limitations emerged, particularly related to the complexity of the design and the challenge of ensuring that all components would be genuinely practical and robust, especially in fast-paced emergency contexts. Although conceptually appealing, the multifunctionality and modular design risked making the object bulky or difficult to use for individuals operating under stress.

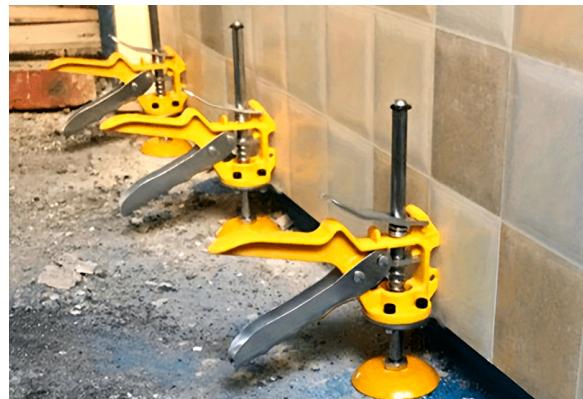


Heise Online - Berlin attack on power supply: Several systems damaged simultaneously  
Yanko Design - Trident Design Tag

## 6.3 Concept 2: Furniture Elevation Systems

The second concept addressed the issue of furniture damage during flooding events, particularly when floors remain wet for extended periods. The idea was to develop modular, low-cost, and easy-to-use elevation systems compatible with existing furniture and designed to be rapidly installed by community members. Inspiration was drawn from mechanical jacks and furniture risers, with the aim of creating open, reusable, and adaptable solutions suitable for different situations.

The main strength of this concept lay in its simplicity and practicality, as it enabled effective protection of furniture without the need for complex interventions. However, certain aspects raised concerns, particularly regarding aesthetic perception. Despite its functional value, the design of the elevation systems risked appearing unattractive and therefore might not encourage young users to keep them in their homes during non-emergency periods. In addition, the effectiveness of the system was highly dependent on correct installation, and in emergency situations rapid assembly could prove challenging.



Amazon AE - Heavy Duty Furniture Mover Tool Set  
Sekai Class - Table and Desk Leg (75 cm)

## 6.4 Concept 3: Water Drainage Pump

The third concept, which was selected as the basis for the final project, involved a simple water drainage pump that could be produced using low-cost components and easily manufactured through 3D printing. The idea was to provide an immediate tool to help people remove water before the arrival of emergency services, in a way that is fast, simple, and affordable. What made this concept particularly compelling was its concreteness. It was easy to use, highly replicable, and adaptable to different situations, without requiring specialised skills or significant financial investment.

Unlike the first two concepts, this solution focused on a single, clearly defined, and immediately useful function, thereby reducing risks and inefficiencies. A potential limitation concerned the volume of water that could be drained within very short timeframes. Overall, however, the simplicity, accessibility, and open nature of the design demonstrated the greatest potential for practical implementation and widespread adoption within the community.



Google Search - Water drainage pump for shops in Venice  
Metropolitano.it - High water in Venice: New regulations for adaptation

## 6.4 Concept 3: Water Drainage Pump

The water drainage pump concept was developed according to a set of clear design guidelines intended to ensure that the tool would be functional, durable, and accessible to a wide range of users. One of the core principles is open design, which enables the free sharing of models and instructions, supporting reproduction and adaptation by different communities. This approach not only increases the dissemination of the tool but also encourages active participation in its construction, use, and maintenance.

Affordability and ease of assembly were identified as additional key criteria. The pump is designed using components that are either easily available on the market or suitable for 3D printing, thereby reducing overall costs and allowing assembly without specialised tools or advanced technical skills. Simple assembly is particularly important in emergency situations, where rapid intervention is essential.

Functionality and durability were also central to the design process. The pump must be capable of effectively draining accumulated water while withstanding repeated use in demanding conditions without breaking or losing efficiency. Achieving a balance between simplicity, robustness, and performance ensures that the device can provide meaningful support to communities during flood events, especially in the critical period before emergency services arrive.

These guidelines made it possible to define a clear, practical, and replicable concept that integrates accessibility, functionality, and durability into a single device suitable for flood response.

## Summary of design guidelines

-  **Open design:** models and instructions are shareable and adaptable by the community.
-  **Affordability:** use of low-cost components or parts suitable for 3D printing.
-  **Ease of assembly:** rapid assembly without specialised skills or equipment.
-  **Functionality:** effective water drainage capability.
-  **Durability and robustness:** structure designed to withstand repeated use in emergency conditions.
-  **Accessibility:** intended for use by anyone, including individuals without technical experience.

07

# WATER DRAINAGE PUMPS

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EXISTING DRAINAGE PUMPS AND MARKET BENCHMARKS INFORM THE DEFINITION OF TECHNICAL AND FUNCTIONAL REQUIREMENTS. THE POSITIONING OF THE PROPOSED OPEN-DESIGN SOLUTION IS CLARIFIED.

## **7.1 Intended use and application contexts**

The water drainage pump was designed with the primary objective of rapidly removing water in emergency situations or during everyday use, such as floods, domestic leaks, or the emptying of tanks. Its function is to move clean or slightly contaminated water efficiently, providing a portable and easy-to-use solution that can also operate effectively in improvised or non-specialised contexts.

The application contexts are diverse and address both domestic and community needs. The pump can be used in houses and apartments, particularly for draining flooded basements or garages, but it is also suitable for use in campers, small agricultural settings, or for immediate interventions following heavy rainfall.

In addition, the pump can be employed to empty water tanks or containers, making it a versatile and practical tool for both emergency response and everyday activities.

## **7.2 Benchmarking analysis**

To evaluate the water drainage pump concept, a benchmarking analysis was conducted on the main portable and submersible pumps currently available on the market. The aim was to understand the technical characteristics, fields of application, and limitations of existing products, in order to better define the requirements, functions, and advantages of the proposed design concept.

### Submersible 12 V / Portable Pump (Camper, Emergency)

**Purpose:** small-scale flooding, emptying containers, minor leaks, emergency use without domestic electricity.

**Technical features:** flow rate approximately 16 l/min, 12 V power supply compatible with batteries, limited lifting height of a few metres.

**Strengths:** low cost, compact size, easy to transport.

**Limitations:** low flow rate, suitable only for small-scale interventions.

**Price range:** €20–€50.



### Piranha Bilge Lænsespumpe 25 l/min.

<https://www.campmarket.dk/dk/carbest-vandpumpe-16l>

### Portable Utility Low-Voltage Pump (12–24 V)

**Purpose:** small applications requiring a higher flow rate than micro pumps, such as draining tanks or limited flooding.

**Technical features:** flow rate approximately 25 l/min, pressure around 0.7 bar, 12–24 Vv power supply or battery operation.

**Strengths:** higher flow rate compared to very small pumps, versatile use.

**Limitations:** still limited for large surfaces or more demanding interventions.

**Price range:** €80–€200.



### Carbest Vandpumpe 16

<https://www.nordiskcampingudstyr.dk/shop/piranha-bilge-laensespumpe-6575p.html?CookieConsentChanged=1>

### Light Domestic Submersible Pump for Dirty or Mixed Water

**Purpose:** moderate flooding in basements or garages, water containing small debris.

**Technical features:** flow rate of 35–40 l/min, dry-run protection, automatic float switch, robust plastic and metal housing.

**Strengths:** durable, suitable for dirty or mixed water, automatic operation.

**Limitations:** not suitable for industrial use or very large volumes.

**Price range:** €150–€250.



### Dirt Water Pump GC-DP 3730; EX; ARG

<https://www.einhell.com.ar/en/p/4170472-gc-dp-3730-ex-arg/>

### Submersible Pump for Clean Water (Medium Power)

**Purpose:** rapid removal of clean water after heavy rainfall, can function as a primary domestic pump.

**Technical features:** 300 W power, 230 V power supply, robust construction, often stainless steel.

**Strengths:** high flow rate for clean water, solid and durable.

**Limitations:** not suitable for dirty water or water containing debris.

**Price range:** €70–€130.



### Vandpumpe PF1010

<https://www.makita.dk/product/pf1010.html>

### Flat-Water Pump (Low-Level Water, Emergency Domestic Use)

**Purpose:** removal of residual water at very low levels, for example beneath doors or skirting boards.

**Technical features:** near-flush suction, good flow rate, 230 V power supply, compact construction.

**Strengths:** ideal for very shallow water and precision interventions.

**Limitations:** limited overall drainage capacity.

**Price range:** €100–€200.



### Dykpumpe - fladsugning SP 9.000 Flat

<https://www.karcher.com/dk/home-garden/pumper/dykpumper/sp-9-000-flat-16458100.html>

### Deep-Well or Medium-Flow Pump

**Purpose:** extraction from deep wells or tanks, backup solution for larger volumes.

**Technical features:** flow rate around 105 l/min, motor with good lifting capacity, robust housing, resistance to sand or semi-solids depending on the model.

**Strengths:** suitable for large volumes, robust and durable.

**Limitations:** higher cost, bulkier size, reduced portability.

**Price range:** €250–€400.



### VEVOR Submersible Pump for Deep Wells

[https://eur.vevor.com/deep-well-pump-c\\_11104/vevor-deep-well-submersible-pump-stainless-steel-water-pump-750w-105l-min-62-m-p\\_010779379399?lang=da](https://eur.vevor.com/deep-well-pump-c_11104/vevor-deep-well-submersible-pump-stainless-steel-water-pump-750w-105l-min-62-m-p_010779379399?lang=da)

This overview highlights how pumps differ in terms of flow rate, type of water handled, ease of use, and cost. By comparing these products, it was possible to identify the essential characteristics for the proposed concept: simplicity, affordability, portability, and effective drainage capability in emergency situations.

### 7.3 Definition of the design characteristics of the pump

The open-design portable pump was developed as a simple, low-cost, and immediately usable tool for managing flooding or water accumulation, particularly in the period before local authorities can respond. Its main goal is to provide a safe, lightweight, and intuitive device suitable for rapid small-scale interventions, accessible to both individuals and community groups in need of immediate support.

The pump is designed to deliver a flow rate of approximately 20–40 litres per minute, which is sufficient for small-scale emergency drainage. It is powered by a 12 V battery, with an optional 230 V adapter for domestic use, and weighs less than 1 kg, making it easy to carry, transport, and deploy even by untrained users.

Following open-design principles, the pump is built using only 3D-printable parts and simple, easily available components such as standard screws and hydraulic hoses. Its assembly requires only a few basic tools and can be performed intuitively by users without technical expertise. The pump is durable, capable of handling small debris up to 3–5 mm in size, and its modular design allows individual parts to be easily repaired or replaced, supporting shared or community-based use. Material costs are intentionally kept low, targeting less than 30 euros per kit.

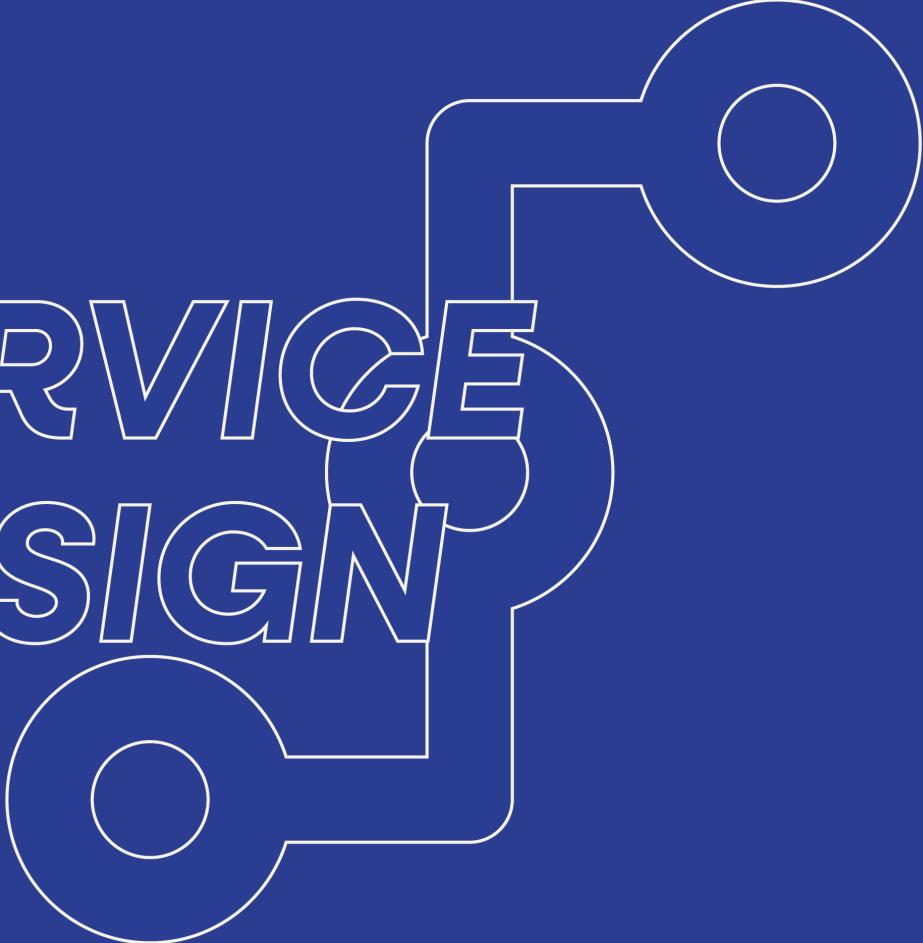
The project also incorporates design “hacking” principles, creatively repurposing common objects for new functions. In this case, the pump can be powered

using a standard drill and connected to a vacuum cleaner hose to rotate the impeller, enabling fluid transfer in emergency situations. These strategies allow the pump to be adapted to different contexts using readily available resources, while maintaining flexibility, reparability, and rapid deployment.

### Summary of design characteristics

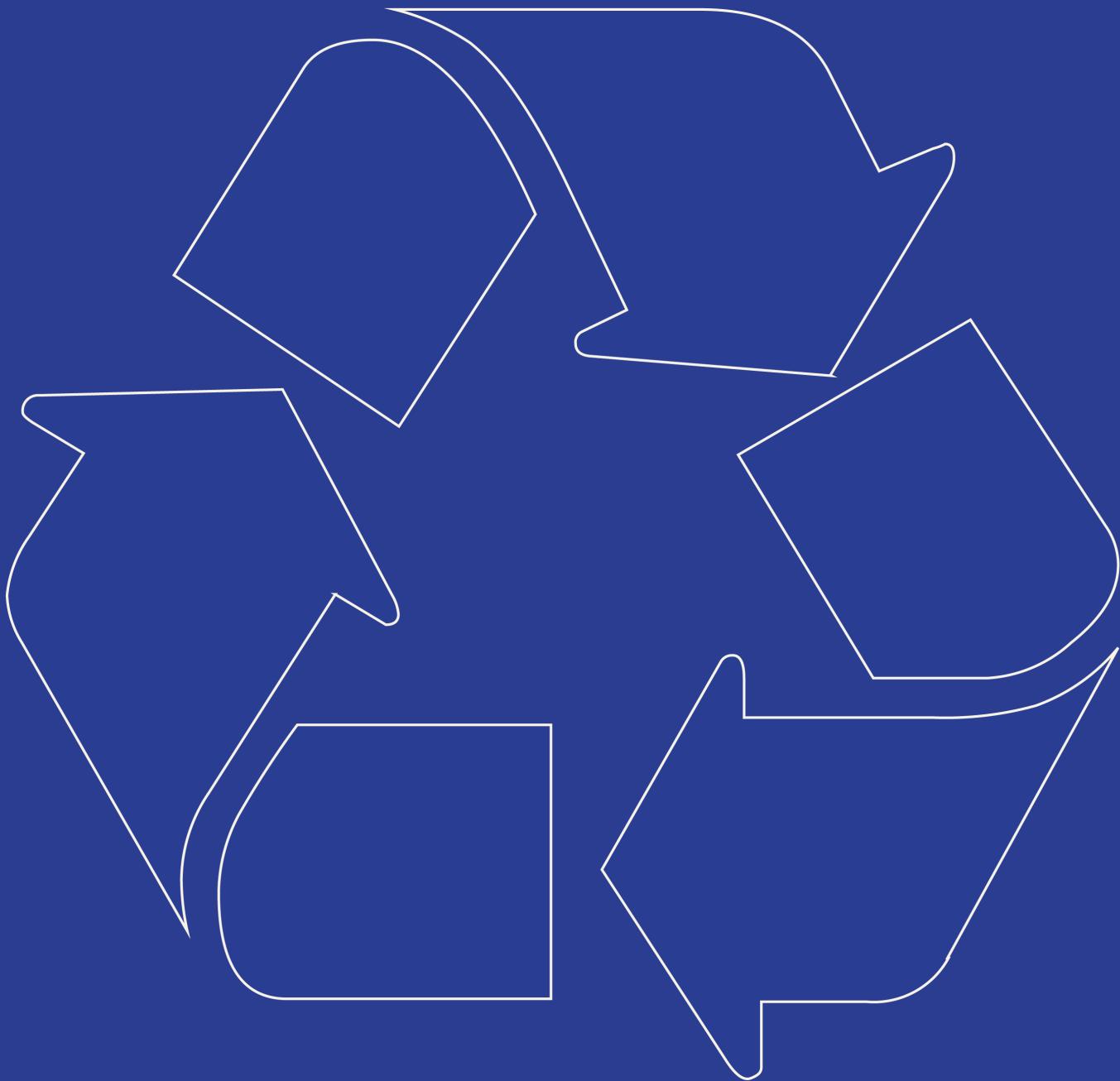
-  **Flow rate:** 20 to 40 l/min, suitable for small emergency drainage tasks
-  **Power supply:** 12 V battery, with optional 230 V adapter for domestic use
-  **Portability:** lightweight design, less than 1 kg, easy to carry and transport
-  **Construction:** open-design approach using only 3D-printable parts and simple, easily available components such as standard screws and hydraulic hoses
-  **Ease of use:** simple assembly, minimal tools required, intuitive for non-technical users
-  **Durability:** robust structure designed to last several years
-  **Affordability:** target material cost below €30 per kit
-  **Modularity and reparability:** easily replaceable parts, suitable for shared or community use
-  **Creative design principles:** adaptable through the use of a standard drill and a vacuum cleaner hose to actuate the pump

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*SERVICE  
DESIGN*

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08

# DEVELOPING SERVICE DESIGN

THE PRODUCT IS EMBEDDED WITHIN A NEIGHBOURHOOD-BASED SERVICE SYSTEM THAT ENSURES ACCESS AND SHARED USE. THIS APPROACH STRENGTHENS THE COMMUNITY-ORIENTED AND COLLABORATIVE DIMENSION OF THE PROJECT.

Service design represents a fundamental component of the thesis project, as it enables the transformation of the open-design portable pump from a purely technical artefact into a neighbourhood-based social infrastructure. The project acknowledges that, in contexts of widespread yet non-critical emergencies, the mere availability of a product is not sufficient. What is required is the construction of a system that ensures

access, learning, correct use, and long-term maintenance.

The service is conceived as a civic device for rapid response to small-scale domestic flooding, grounded in citizen collaboration, the valorisation of local skills, and the use of existing shared spaces. In this sense, the project is positioned at the intersection of product design, service design, and design for urban resilience.

## 8.1 Introduction and definition of the problem

In recent years, phenomena such as intense rainfall, extreme weather events, and the progressive deterioration of urban infrastructure have led to an increasing frequency of domestic flooding and water accumulation in private and semi-private environments. Although these situations do not always fall within the category of severe emergencies, they nonetheless generate material damage, stress, and conditions of vulnerability, particularly during the initial phases of the event.

The core problem does not lie solely in the lack of adequate technologies, but rather in social and organisational barriers. Professional interventions, such as those provided by fire brigades or specialised companies, are often slow, costly, or unavailable for situations perceived as “minor”. As a result, many individuals are left without appropriate tools to act autonomously and in a timely manner.

This condition disproportionately affects:

- ⌵ **Older adults**
- ⌵ **Individuals living alone**
- ⌵ **Residents with limited technical skills**
- ⌵ **Communities with poor access to local support networks**

The project establishes direct connections among these actors, fostering a logic of mutual support. Individuals who possess skills or tools are enabled to share them with those in need, while community spaces act as enabling infrastructures for the service, facilitating access, coordination, and collective engagement.



Photo by Beth Macdonald on Unsplash

## 8.2 Stakeholder map

The service operates within a structured ecosystem of stakeholders, each contributing to the functioning of the system through distinct roles and responsibilities. The design process takes into account the relationships among these actors, with the aim of reducing the physical and relational distances that often hinder mutual support.

The main stakeholders include:

- ↘ **Neighbourhood residents**, directly exposed to flood risk and serving as the primary beneficiaries of the service.
- ↘ **Older adults** and individuals with reduced mobility, identified as priority users in the design of accessibility and support mechanisms.
- ↘ **Volunteer builders and assemblers**, often young adults or students with basic technical skills who contribute to the construction and maintenance of the pumps.

↘ **Tool donors**, namely residents who own domestic equipment such as drills and are willing to share them when needed.

↘ **Community spaces**, including libraries, neighbourhood centres, and student residences, which function as physical hubs for the service.

↘ **FabLabs and maker communities**, which support production, replicability, and dissemination of the open-design project.

The project addresses this critical issue by proposing a solution that combines an open-design physical product with a locally grounded support service, with the aim of reducing both the temporal and relational gap between the occurrence of flooding and effective intervention. Integrated within a service system, the pump becomes a tool for strengthening community autonomy and resilience.



Photo by Matheus Ferrero on Unsplash

## Stakeholder map

### Physical / Relational Distance

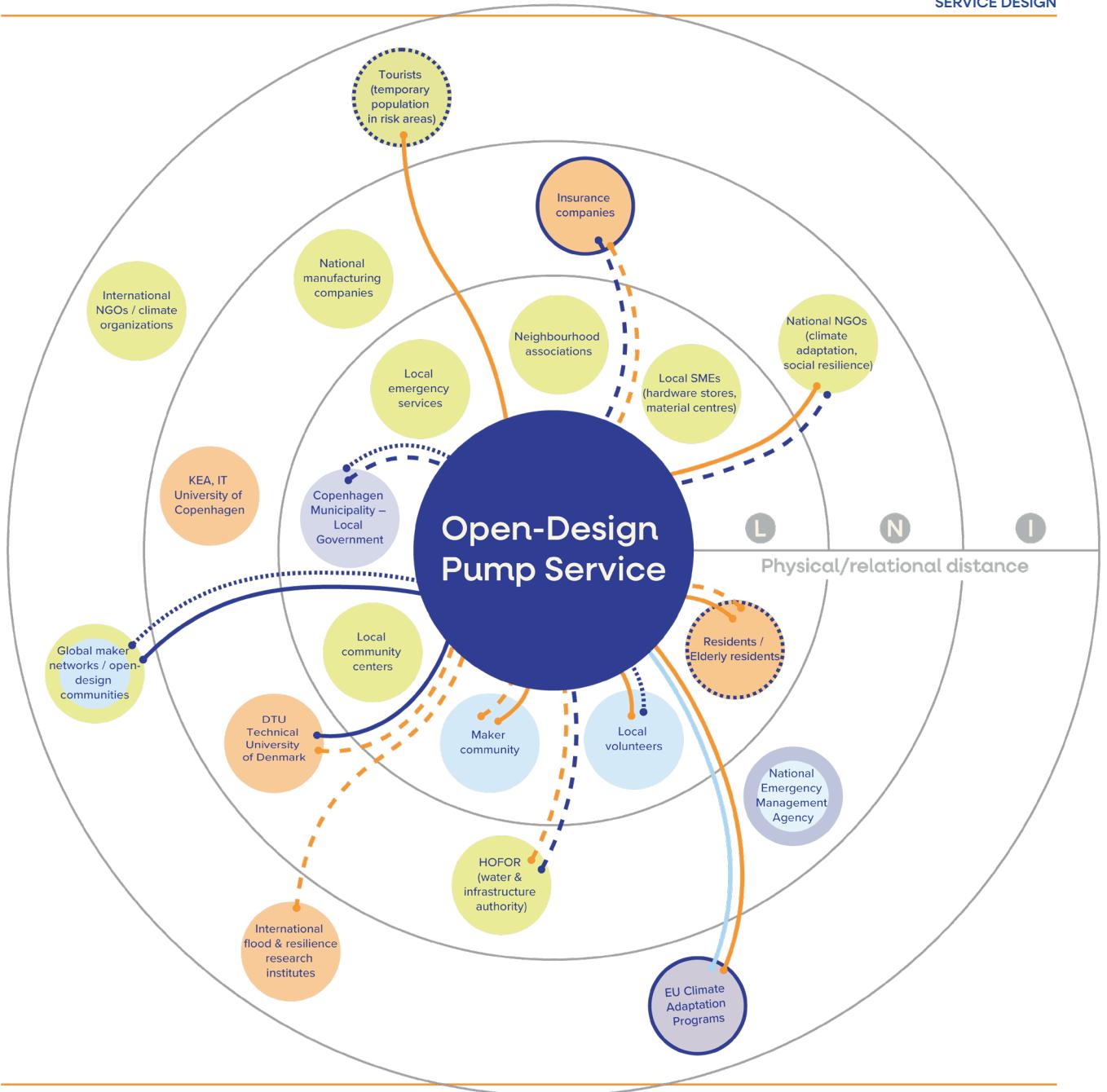
-  Local
-  National
-  International

### Stakeholder Groups

-  Operational Stakeholders / Service Provision
-  Informational / Knowledge Stakeholders
-  Regulatory / Authorizing Stakeholders
-  Financial / Funding Stakeholders
-  End Users / Beneficiaries

### Stakeholder–Project Connections

-  Service provided / operational contribution
-  Information flow / knowledge exchange
-  Money / funding
-  Mutual service exchange / collaboration
-  Regulation, authorization, licensing
-  Minor operational interaction



### 8.3 Primary users and user personas

The project acknowledges that domestic flooding emergencies involve individuals with different skills, resources, and levels of vulnerability, and that an effective response depends on the coordination of multiple user profiles. Primary users are defined according to their role and degree of direct involvement, with a focus on two main groups: residents directly affected

by flooding and individuals who enable the service through technical skills, tools, and local presence. This distinction allows the project to move beyond an individual-centred view of the user and adopt a collaborative ecosystem perspective, where the service operates through the interaction of complementary needs, roles, and resources.

#### Persona 1 – Elder Resident



NAME **Anne Nielsen**

AGE **72**

OCCUPATION **Retired school administrator**

LOCATION **Odense, Denmark**

TECH FAMILIARITY **Basic smartphone user**

#### Motivation

Anne remembers a few summers ago when heavy rainfall caused a small flood in her basement. A bit of water leaked in via the cellar window. At that time, she panicked. By the time the maintenance service arrived, much of her stored clothing had been ruined. Since then, every forecast of heavy rain makes her anxious. She often worries over small cracks, damp spots, or rising water levels around the house. She would like to feel more in control and less vulnerable.

#### Expectations & Needs

-  Ready to use modular pump
-  Clear step-by-step instructions or phone guidance
-  Quick emergency response
-  Sense of social connection and autonomy

#### Values

PEACE OF MIND

INDEPENDENCE

COMMUNITY SUPPORT

## Persona 2 – Young Maker / FabLab Volunteer



NAME **Asger Jensen**

AGE **24**

OCCUPATION **Mechanical engineering student /  
FabLab volunteer**

LOCATION **Aarhus, Denmark**

TECH FAMILIARITY **CAD, 3D printing, assembly**

### Motivation

Asger grew up in a suburb of Aarhus that occasionally experienced spring floods. As a teenager, he helped neighbours pump out water with old sump pumps, realizing how vulnerable some community members are, especially the elderly. Later, at the FabLab, he discovered the potential of 3D printing and modular design. Aware of climate change and the increasing frequency of extreme weather, he is motivated to use his skills to create solutions that strengthen community resilience and protect people from environmental risks.

### Values

MEANINGFUL APPLICATION OF SKILLS

SOCIAL IMPACT

### Expectations & Needs

-  Ready-to-print STL files and assembly instructions
-  Quick, geolocated notifications for nearby emergencies
-  Recognition: badges, points, or material incentives
-  Lean and efficient workflow

ENVIRONMENTAL AWARENESS

COMMUNITY ENGAGEMENT

## 8.4 User needs

The analysis of users highlights a set of specific needs that guided the design of the service.

Residents require:

- ④ A tool that is easily accessible within their living environment
- ④ Immediate and intuitive use, even under conditions of stress
- ④ Clear instructions, primarily visual in nature
- ④ The possibility of relying on local, non-institutional support

Facilitators and assemblers, by contrast, require:

- ④ A modular and repairable project
- ④ Open-design documentation that can be easily shared
- ④ Suitable spaces for assembly and training activities
- ④ A system that recognises and values their contribution within the community



Photo by Darya Tryfanava on Unsplash

## 8.5 Service overview

The service is structured as a system articulated around three main phases: training, access, and use. The training phase takes place through neighbourhood workshops organised in community spaces. During these workshops, participants assemble the open-design pump, learn how it operates, and test its use through simulated scenarios. The workshop plays a central role in reducing the distance between users and technology, fostering familiarity, confidence, and shared responsibility.

The access phase concerns the physical placement of the pump within residential buildings. Each pump

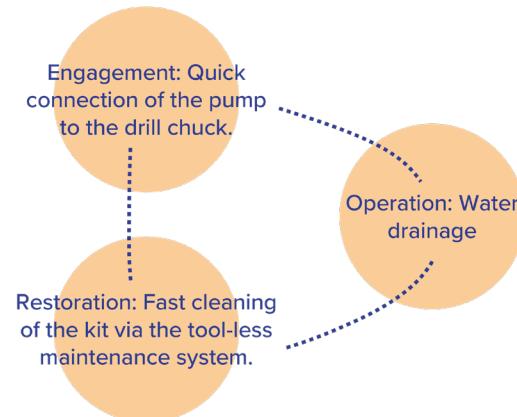
is stored in a dedicated box located in corridors or common areas that are easily identifiable. The box contains the pump, essential components, and an explanatory poster illustrating the steps for use and return, ensuring clarity and ease of access during emergency situations.

The use phase is activated in the event of flooding. A resident retrieves the pump, operates it by following the provided instructions, and, once the intervention is completed, cleans and returns it to the box, making it available again for the community. This cycle reinforces shared use, collective care, and the continuity of the service over time.

### Preventive Phase



### Emergency Phase User Cycle:



## 8.6 User journey

The user journey of the resident highlights how the service is designed to support individuals along a pathway that begins before the emergency and continues after the use of the tool, moving beyond a perspective limited to the critical moment alone. The project acknowledges that the effectiveness of the intervention largely depends on prior familiarity with the service and on the clarity of its touchpoints.

The initial phases of the user journey, related to awareness and learning, play a crucial role in reducing the psychological and technical barriers associated with the use of a mechanical device. Neighbourhood workshops and the visible presence of the pump in shared spaces contribute to building trust, making the object recognisable and mentally accessible even to non-expert users.

At the moment of emergency, the user journey emphasises the importance of immediate access and ease of use. The box located in corridors and the poster with visual instructions enable users to act quickly, even under conditions of stress, without the need for advanced technical skills or external assistance. The design of physical touchpoints therefore responds to the need to minimise required actions and reduce the risk of error.

The phases following use, including cleaning, return, and consolidation of the experience, highlight the collective dimension of the service. The system does not rely on formal control mechanisms, but on a principle of shared responsibility, in which each user contributes to keeping the pump available for the entire community. This aspect strengthens the sense of belonging and transforms an individual act of use into a practice of collective care.

Overall, the user journey illustrates how the project integrates product and service into a single, continuous experience, in which the open-design pump becomes not only a technical tool but an active element of local resilience and neighbourhood collaboration.

1. AWARENESS

2. LEARNING

3. FAMILIARISATION

4. EMERGENCY

5. ACCESS & SETUP

6. USE &  
VRESOLUTION

7. POST-USE

8. CONSOLIDATION

CONTEXT / SITUATION	USER ACTIONS	SERVICE TOUCHPOINTS	USER NEEDS	SERVICE RESPONSE	POTENTIAL ISSUES
Everyday neighbourhood life	Learns about the service through local communication	Posters, neighbourhood messages, workshops	Know that a local solution exists	Visible presence in shared spaces	Low initial interest
Community space	Attends a short practical workshop	Facilitators, pump, demonstrations	Understand use without technical skills	Simple language and hands-on learning	Fear of incorrect use
Shared building spaces	Recognises the pump and its location	Pump box, visual poster	Easily find the tool	Sends alert, indicates availability of drill	Poor visibility
Domestic flooding	Notices water and decides to act	Pump box, quick instructions	Act quickly to limit damage	Fixed and visible placement	Stress and urgency
Shared space / flooded area	Takes the pump and prepares it for use	Notices flooding at own home or nearby	Easy and fast setup	Intuitive design and clear instructions	Missing or disordered parts
Flooded environment	Uses the pump to remove water	Own home, neighborhood	Effective and safe use	Suitable performance for small floods	Limited capacity in severe cases
Shared space	Cleans and stores the pump	Realizes water entering basement or hears about neighbor's flooding	Know what to do after use	Clear post-use instructions	Tool not cleaned
Neighbourhood life	Gains trust in the service	Uncertainty about safety or permission	Feel supported by the community	Strengthened local resilience	Decline in long-term engagement

# 09

# USER RESEARCH AND INTERVIEWS

## QUALITATIVE INTERVIEWS EXPLORE EXPERIENCES AND NEEDS RELATED TO DOMESTIC FLOODING. THE FINDINGS SUPPORT THE VALIDATION AND REFINEMENT OF DESIGN DECISIONS.

The user research phase aimed to develop an in-depth understanding of the needs, motivations, and perceived barriers experienced by the main actors involved in the service. In particular, the research focused on two key profiles previously identified in the stakeholder map: technically skilled volunteers and older residents, who are often more exposed to the effects of domestic flooding.

The adopted methodology was the semi-structured qualitative interview, which made it possible to explore not only functional aspects related to the use of the service, but also emotional, relational, and organisational dimensions. The interviews were structured around six main thematic areas: personal context, relationship with the project, motivations, pain points and barriers, support needs, and perceived impact.

## 9.1 Interview 1: Elio Ponsetto

Elio Ponsetto, 27 years old, an automotive engineer, represents the profile of a young volunteer with technical skills who could potentially be involved in the assembly, dissemination, and operational support of the service.

The interview reveals a strong motivation linked to the desire to acquire new skills and to feel part of a project that is genuinely useful and capable of producing a tangible impact on the community. Elio emphasises that volunteering is perceived as meaningful only when individual contributions are clearly visible and not experienced as merely symbolic or self-referential.

Among the main critical issues identified, several organisational problems emerge, including unclear communication, last-minute information delivery, and the absence of a stable point of reference. According to the interviewee, these factors significantly reduce both motivation and the overall effectiveness of voluntary work. By contrast, Elio highlights the importance of clear guidance, well-defined roles, and the presence of a dedicated contact person to address questions or uncertainties.

Another relevant aspect concerns the working environment. The interviewee values collaborative, calm, and informal contexts in which interaction with others is encouraged and a sense of sociality and lightness can develop. Even simple forms of recognition, such as explicit expressions of appreciation, are perceived as important elements for strengthening a sense of belonging and long-term engagement.

These insights directly informed the service design, particularly in shaping the workshops as structured yet informal moments characterised by clear roles and concrete objectives.

### 1. Background & Personal Context

- Can you briefly introduce yourself and your typical weekly routine?
- How long have you been involved in volunteering or community activities?
- What motivates you to volunteer?

### 2. Relationship with the Project Volunteering

- What kind of tasks or roles would you feel comfortable taking on?
- What skills or strengths do you think you bring to the project?

### 3. Expectations & Motivations

- What type of environment helps you feel engaged and motivated?
- How important is learning new skills or collaborating with others for you?

### 4. Pain Points & Barriers

- What are the main obstacles that might prevent you from volunteering regularly?
- Have you ever had negative experiences in volunteering? What happened?
- Are there organizational issues that typically discourage you (e.g., poor coordination, unclear tasks, limited resources)?

### 5. Needs & Desired Support

- What kind of support or tools do you need to do your tasks well?
- How should communication be managed to help you feel informed and included?

- What would make the experience more enjoyable or efficient for you?

## 6. Perception of Impact

- How important is it for you to see your contribution making a difference?
- What kind of feedback or recognition do you value?
- How would you like to be involved in decision-making, if at all?

## Key Insights

- Ⓣ MOTIVATIONS **Wants to learn new skills and feel part of a useful group, not just participate “for the sake of it.”**
- Ⓣ ROLE AND SKILLS **Brings calmness and manual dexterity, useful for managing groups in less organized situations.**
- Ⓣ PAIN POINTS / CHALLENGES **Last-minute information or chaotic organization reduces motivation and effectiveness.**
- Ⓣ NEEDS AND SUPPORT **Needs clear guidance and a point of contact for resolving doubts.**
- Ⓣ PERCEPTION OF IMPACT **Appreciates even small recognition (“thank you”) and wants to see tangible results from his contribution.**
- Ⓣ IDEAL EXPERIENCE **Calm and collaborative environment with opportunities for social interaction and some fun.**

## 9.2 Interview 2: Bente Faurby

Bente Faurby, 65 years old, a retired yoga instructor, represents the profile of an older resident who could be a direct beneficiary of the service in the event of domestic flooding.

The interview highlights a strong need for safety, simplicity, and reliability. Bente explains that emergency situations, even when limited in scale, can generate anxiety and stress, particularly when instructions are unclear or tools appear complex.

The interviewee demonstrates good knowledge of her neighbourhood and a willingness to carry out tasks accurately, provided that they are accompanied by clear and sequential instructions. By contrast, technologies perceived as overly complex or ambiguous tend to slow down reaction times and increase uncertainty.

A central element that emerged concerns communication. Bente reports feeling reassured by simple and direct messages, such as confirmation that “a volunteer is on the way”, and she places high value on visible and immediate outcomes. With regard to information channels, she prefers traditional and local tools, such as posters or physical notices, over solutions that rely exclusively on digital platforms.

These insights guided the project towards:

- a clear and highly visual physical interface
- step-by-step instructions
- a tangible presence of the service within everyday spaces

### 1. Background & Personal Context

- Could you tell me a bit about yourself and how long you've lived in the area?
- What do you enjoy most about the neighborhood?
- Are you actively involved in community activities? Why or why not?

### 2. Relationship with the Project Volunteering

- How do you usually get information about what happens in the neighborhood?
- How connected do you feel to local initiatives or projects?
- What would you like to see improved in the area?

### 3. Expectations & Motivations

- What are your first impressions about the project?
- What makes you feel positive or concerned about initiatives like this?

### 4. Pain Points & Barriers

- What worries you the most about new projects happening nearby?
- Have you had past experiences where a community project caused inconvenience?
- Are there specific issues in the area that affect your everyday life (noise, safety, traffic, accessibility)?

### 5. Needs & Desired Support

- What do you expect from a project taking place in your neighborhood?
- How can we make sure it feels accessible and beneficial to residents?

- What type of communication works best for you? (posters, meetings, mail, online, door-to-door, etc.)

## 6. Perception of Impact

- In what ways, if any, would you like to be involved?
- What makes you feel comfortable engaging with community events?
- What would help you trust and support the project?

## Key Insights

-  **MOTIVATIONS** Looks for simple, trustworthy support that reduces stress and makes her feel safe during emergencies.
-  **ROLE AND SKILLS** Knows her neighborhood well and can follow tasks accurately when given clear, step-by-step guidance.
-  **PAIN POINTS / CHALLENGES** Complex technology or unclear instructions create anxiety and slow her reaction in critical moments.
-  **NEEDS AND SUPPORT** Requires step-by-step visual or voice guidance and wants to know in advance who is coming to help.
-  **PERCEPTION OF IMPACT** Feels reassured if she receives messages like “a volunteer is on the way” and appreciates visible, concrete results.
-  **IDEAL EXPERIENCE** A human, fast, and transparent service: quick response, simple communication, and in-person support that inspires trust.

# 10

# BRAND IDENTITY

A CLEAR VISUAL IDENTITY SUPPORTS PROJECT RECOGNISABILITY AND COMMUNICATES VALUES OF ACCESSIBILITY AND RELIABILITY. GRAPHIC ELEMENTS FACILITATE DISSEMINATION AND ADOPTION.

## 10.1 Moodboard

The moodboard defines a visual language that combines care, calm, and safety with elements of energy and activation. Visual references include clean surfaces, reassuring colours, clear signage, and functional objects, drawing inspiration from both civic design and open-hardware practices. The overall atmosphere is intended to reduce anxiety associated with emergency situations and to present the service as approachable, trustworthy, and reliable.

Tangerine

#f49731

Sky

#a9d7f2

Electric

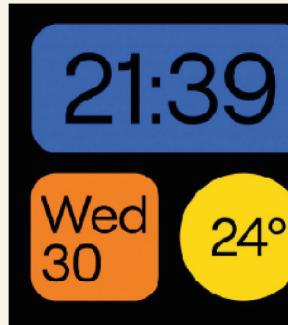
#313d91

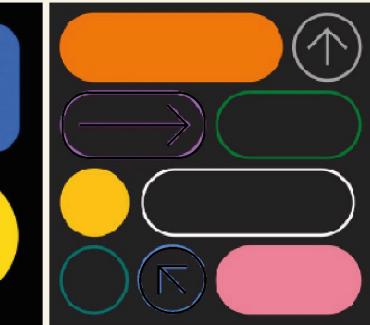
Neon

#d6da2f

Milk

#f7f3e6





# draindrill

## 10.2 Logo

The logo conceptually represents the pump. The name combines the terms drain and drill: the former refers to the function of water drainage, while the latter evokes the motorised mechanism that drives the device.

Together, these two elements communicate both the purpose and the operating principle of the pump in a direct and intuitive manner, making the logo immediately understandable even to non-expert users.



## 10.3 Colour Palette

The colour palette consists of a range that extends from soft and calming tones, such as Latte and Cielo, to more energetic and signal-oriented colours, such as Mandarino and Neon, culminating in the stable and reliable depth of Elettrico (#303E90). This combination balances a sense of care and clarity with energy and visibility, making it suitable for both emergency contexts



## 10.4 Application of colour

The application of colour is designed to support readability and user orientation. More intense colours are used to highlight functional and informational elements, such as instructions or key components of the pump, while more neutral tones help create a reassuring visual background.



## 10.5 Typography

The typographic system is based on the use of two sans-serif typefaces available through Adobe Fonts: Neulis Neue as the primary typeface and Proxima Nova as the secondary typeface. Neulis Neue, a geometric sans-serif, is used for titles and headings, while

Proxima Nova, a hybrid sans-serif combining geometric and humanist characteristics, is employed for body text to ensure high readability.

The typographic hierarchy is designed to facilitate rapid comprehension of information, particularly in informational materials and service-use posters, where clarity and immediacy are essential.

### Primary Typeface

# Neulis Neue

ABCDEFGHIJKLMNOPQRSTUVWXYZ  
abcdefghijklmnopqrstuvwxyz  
0123456789

**Type** Geometric sans-serif

**Designer** Adam Ladd – Adam Ladd Design

**License** Available via Adobe Fonts (commercial + personal use included)

### Secondary Typeface

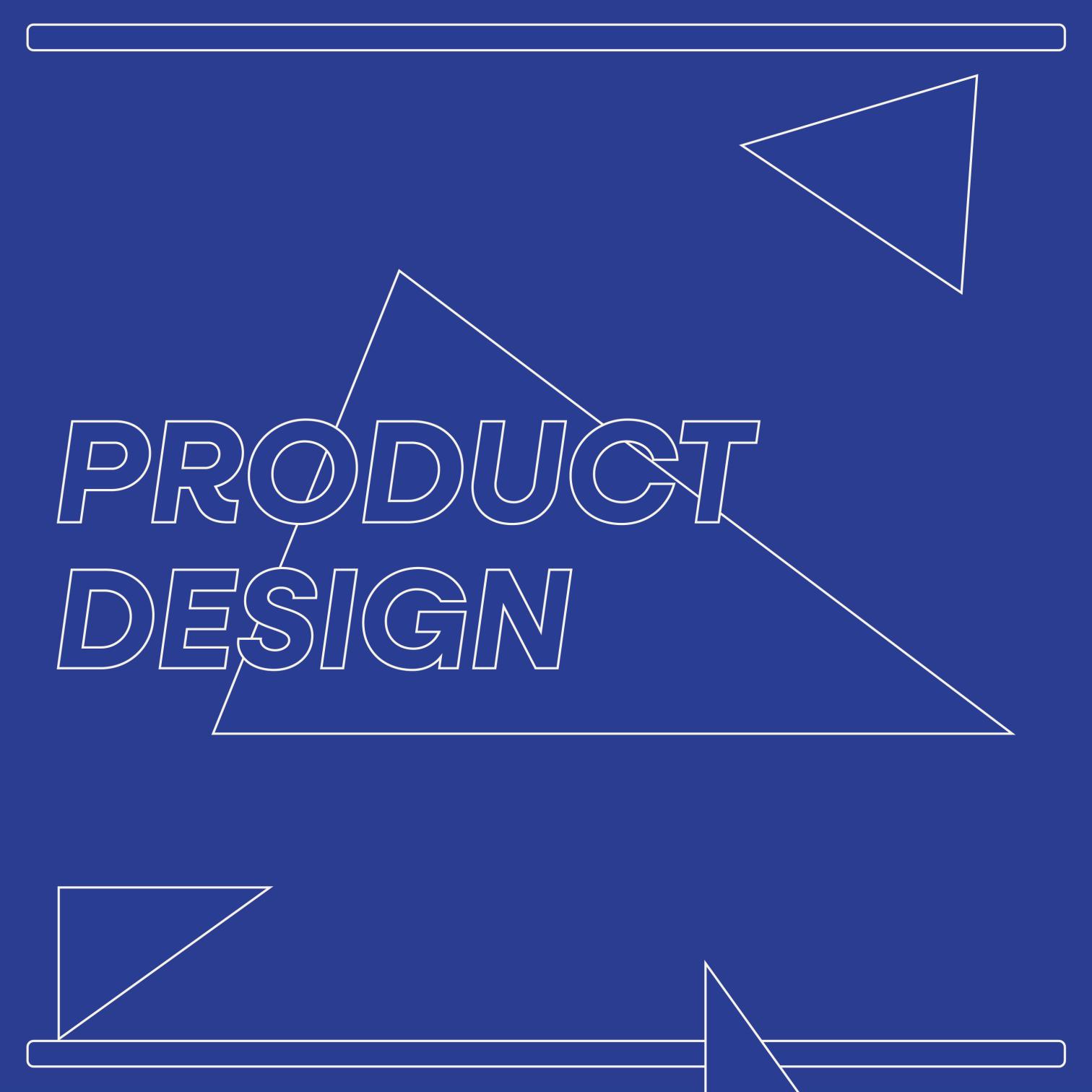
# Proxima Nova

ABCDEFGHIJKLMNOPQRSTUVWXYZ  
abcdefghijklmnopqrstuvwxyz  
0123456789

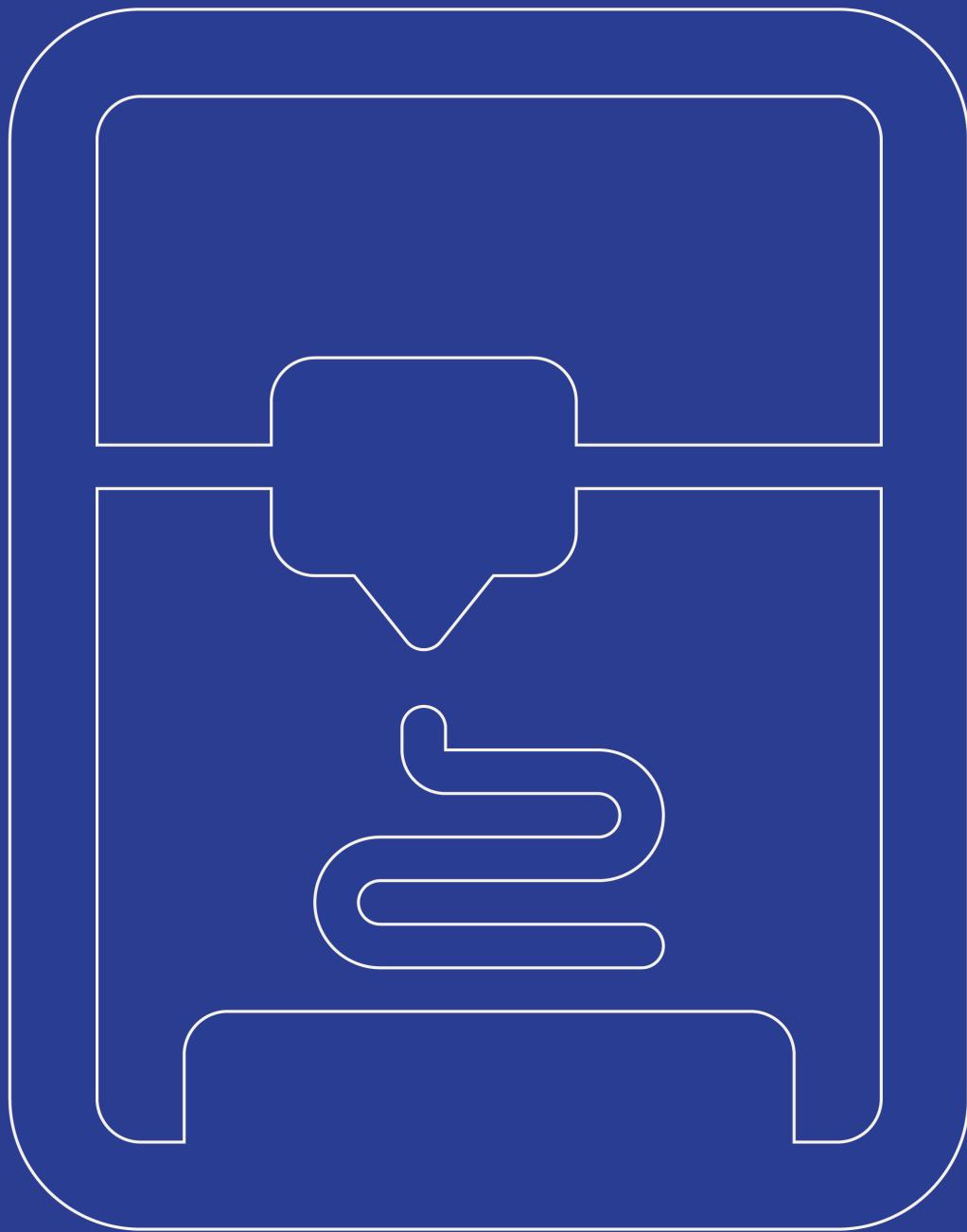
**Type** Hybrid sans-serif (between geometric + grotesque/humanist)

**Designer** Mark Simonson – Mark Simonson Studio

**License** Available via Adobe Fonts (commercial + personal use included)



*PRODUCT  
DESIGN*



# 11

# OPEN-DESIGN EMERGENCY WATER PUMP

THE OPEN-DESIGN EMERGENCY WATER PUMP IS DEFINED THROUGH ITS OPERATION, COMPONENTS, AND DESIGN PRINCIPLES. SIMPLICITY, REPLICABILITY, AND LOW COST GUIDE THE DESIGN CHOICES.

### 11.1 Device objective

The objective of the device is the design of an open-design emergency electric pump intended for the rapid drainage of domestic environments affected by flooding, such as ground-floor apartments or basement spaces. The project is developed based on a realistic and recurrent use scenario, in which a room of approximately 20 m<sup>2</sup> is flooded by a water layer of about 5 cm, corresponding to a total volume of roughly 1,000 litres.

Within this scenario, the pump is designed to enable

the complete drainage of the space within a target time of approximately 30 minutes, a duration considered adequate to limit damage to flooring, furniture, and structural elements. The device is not intended to replace professional or industrial-grade pumps, but rather to provide an intermediate, accessible, and efficient solution suitable for occasional yet critical use. The design objective is therefore to balance technical performance, constructive simplicity, safety, and replicability, in line with an open-design philosophy oriented towards self-construction and the intelligent reuse of existing components.

## 11.2 Main characteristics

The open-design emergency pump is conceived as a compact, modular, and easily assemblable system, designed to operate reliably under domestic emergency conditions. A key design choice underlying the project is the use of a commercially available electric drill as the drive unit, leveraging its ability to deliver high torque and provide direct control over rotational speed.

In terms of performance, the pump is sized to ensure a flow rate of approximately 30–33 litres per minute, a value consistent with the target of draining 1,000 litres in around thirty minutes. The designed operating head is 3 metres, which is sufficient for standard use in ground-floor apartments, while the system is also capable of operating up to 5 metres in more critical scenarios, such as basement environments. Energy consumption is relatively low, with an estimated usage of approximately 0.15 kWh for a 30-minute operating cycle, making the device efficient from an energy perspective.

The system architecture physically separates the drive unit from the hydraulic components, keeping the drill elevated and away from water while the impeller operates fully submerged. This configuration enhances electrical safety and reduces risks associated with moisture and water infiltration.

The pump is therefore conceived as a simplified and modular system capable of addressing domestic emergencies without requiring advanced technical skills. Its main characteristics include:

-  Actuation via a commercially available electric drill, used as the rotational motor
-  A submerged impeller, physically separated from the motor to reduce electrical risk

-  A nominal design flow rate of 30–33 L/min, aligned with the targeted drainage time
-  An effective operating head of 3 m, with tolerance up to 5 m for more demanding scenarios
-  Low energy consumption, estimated at approximately 0.15 kWh for a 30-minute use cycle
-  An open-design structure, manufacturable
-  Using 3D-printable components, standard fasteners, and readily available parts

These characteristics make the pump suitable for occasional yet critical use, such as that required during sudden domestic flooding events.

## 11.3 Existing Open-design solutions

The comparative analysis identified the presence of numerous solutions, both commercially available and open-source, that use an electric drill as the driving motor for small transfer pumps. These devices, often compact and low-cost, are primarily designed for liquid transfer in domestic or hobbyist contexts.

Despite their widespread availability, such solutions exhibit several relevant limitations when considered for emergency flooding scenarios. In particular, many of them are not self-priming and require both the pump body and the suction hose to be filled with water in order to operate correctly. In addition, flow rate and head are often limited, resulting in slow or inefficient drainage, especially in the presence of height differences.

Another critical aspect concerns the positioning of the pump body, which is frequently located very close to the drill chuck. This configuration increases the risk of water infiltration toward the motor, raising safety

concerns during use in wet environments. The thesis project is therefore positioned as a conscious evolution of these existing solutions, retaining their simplicity and accessibility while addressing safety, functional separation, and suitability for real emergency conditions in a more structured manner.

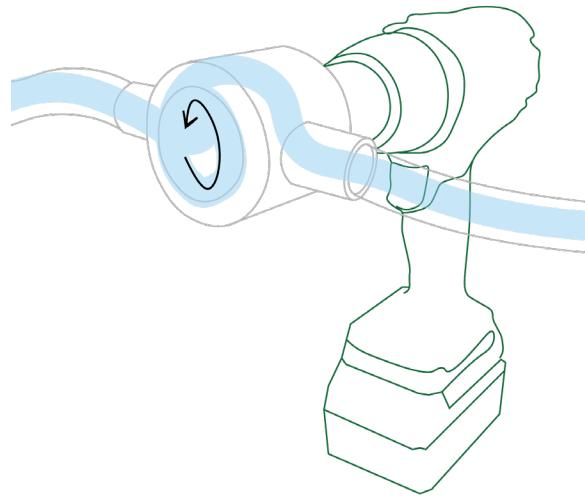
The analysis further highlights the existence of several drill-driven pumps available on the market or through open-source platforms, including 3D-printable models such as open-source drill gear pumps and low-cost commercial devices accessible online. These solutions share a number of common characteristics:

- ⤵ use of an electric drill as the motor,
- ⤵ compact dimensions,
- ⤵ structural simplicity.

At the same time, they present significant limitations, including:

- ⤵ lack of self-priming capability,
- ⤵ reduced flow rate and head,
- ⤵ excessive proximity between the pump body and the drill chuck, with potential infiltration risks.

The thesis project therefore positions itself as a critical refinement of these existing approaches, preserving their advantages while systematically addressing their main design weaknesses, particularly in relation to safety, performance, and emergency usability.



## Existing Open-design solutions



**Gear pump for drill**  
Open source

<https://www.printables.com/model/277351-drill-gear-pump>



**Mini Heavy Duty Self-Priming Electric Drill Water Pump**  
14,00 €

<https://www.aliexpress.com/item/1005005677097515.html>



**Electric Drill Pump**

**Electric Drill Pump Portable**  
16,00 €

[https://www.intercyprus.com/products/electric-drill-pump-portable-small-pumping-pump-mini-hand-drill-self-priming-liquid-transfer-pump-diesel-fluid-water-pump-home-garden-outdoor-tools-multi-scene-liquid-extraction-pump?srsltid=AfmBOoqFewHUIW5qed-VW3mhul\\_UtA64ysikSBxCDUxE00ffijqsy5rCN](https://www.intercyprus.com/products/electric-drill-pump-portable-small-pumping-pump-mini-hand-drill-self-priming-liquid-transfer-pump-diesel-fluid-water-pump-home-garden-outdoor-tools-multi-scene-liquid-extraction-pump?srsltid=AfmBOoqFewHUIW5qed-VW3mhul_UtA64ysikSBxCDUxE00ffijqsy5rCN)



**Powerful Portable Electric Drill Pump**  
37,00 €

<https://www.dhgate.com/product/oil-fluid-water-pump-portable-electric-drill/996610100.html?skuld=1267335148231172119>

## 11.4 Physical operating principle of the pump

The operation of the pump is based on the physical principle of a centrifugal pump. The electric drill, mechanically connected through a coupling and a drive shaft, sets the impeller immersed in water into rotation. This rotation generates centrifugal force, which drives the fluid from the centre of the impeller toward its outer perimeter.

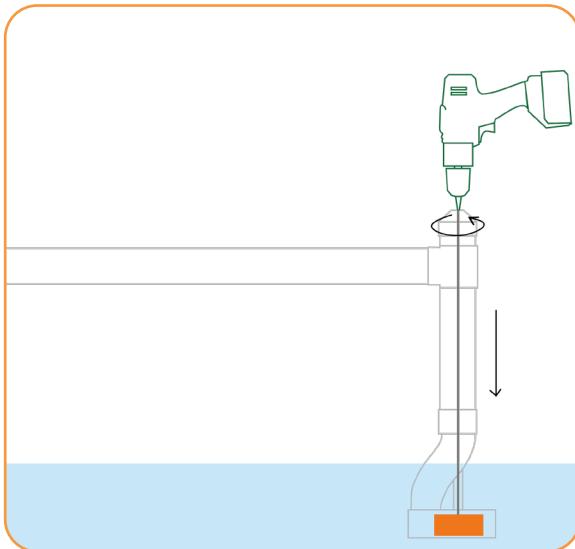
As a result of this motion, pressure decreases in the

central area of the impeller, creating a low-pressure zone that draws additional water from the surrounding environment through the suction inlet. The water expelled radially is then collected by the pump housing and channelled into the discharge hose, which conveys it toward the outlet point.

The process is continuous: as long as the drill remains in operation, the impeller continues to rotate, ensuring a steady cycle of suction and discharge until the flooded environment is fully drained.

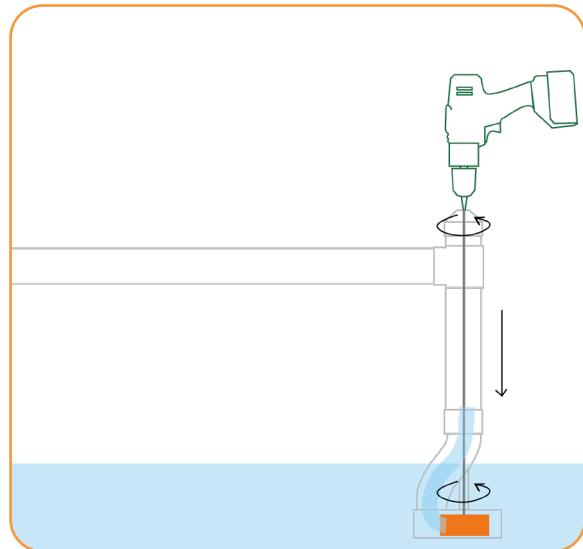
### 1. Mechanical drive:

The drill, connected to the coupling and drive shaft, rotates the impeller.



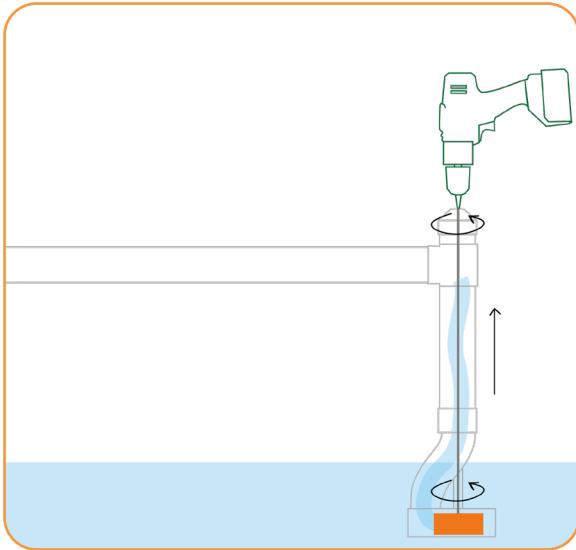
### 2. Creation of depression:

The rotation of the impeller causes the water in the centre to be pushed outwards by centrifugal force. This causes a drop in pressure in the central area, which draws in new water from the outside environment (suction).



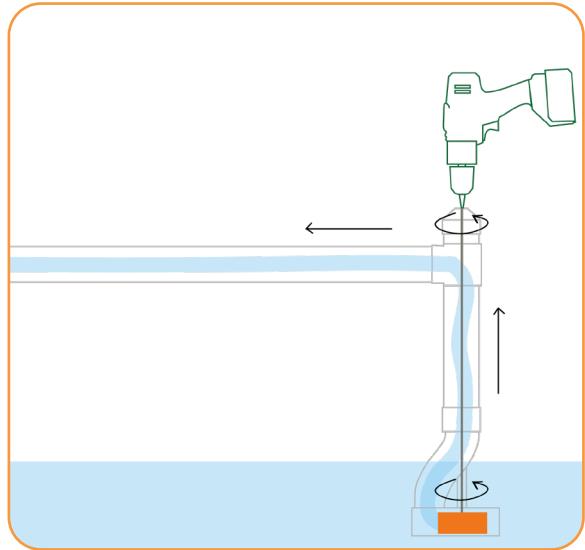
### 3. Water thrust:

The water that is pushed radially towards the periphery of the impeller is collected and conveyed into the discharge pipe, which transports it upwards and finally outwards.



### 4. Continuous cycle:

As long as the drill is running, the motion is continuous and the water is constantly sucked up and pushed out until it is completely drained.



## 11.5 Focus on the electric drill

The electric drill, using a standard high-performance model like the Bosch Professional GSB 13 RE as a reference, serves as the essential external power unit for driving the pumping system. Its primary role is to convert electrical energy into rotational motion, acting as a detachable motor that allows the pump to operate without the need for expensive integrated motorized components. This specific model is ideal for this application due to its versatility: it operates with a power input of approximately 600W and offers an adjustable no-load speed reaching up to 2,800 revolutions per minute (rpm). A crucial feature is the electronic speed preselection dial and the pressure-sensitive trigger, which allow the user to precisely modulate the rotation speed and, consequently, control the water flow rate according to drainage needs. Furthermore, the keyed or keyless chuck ensures a quick and secure connection to the system's drive shaft.



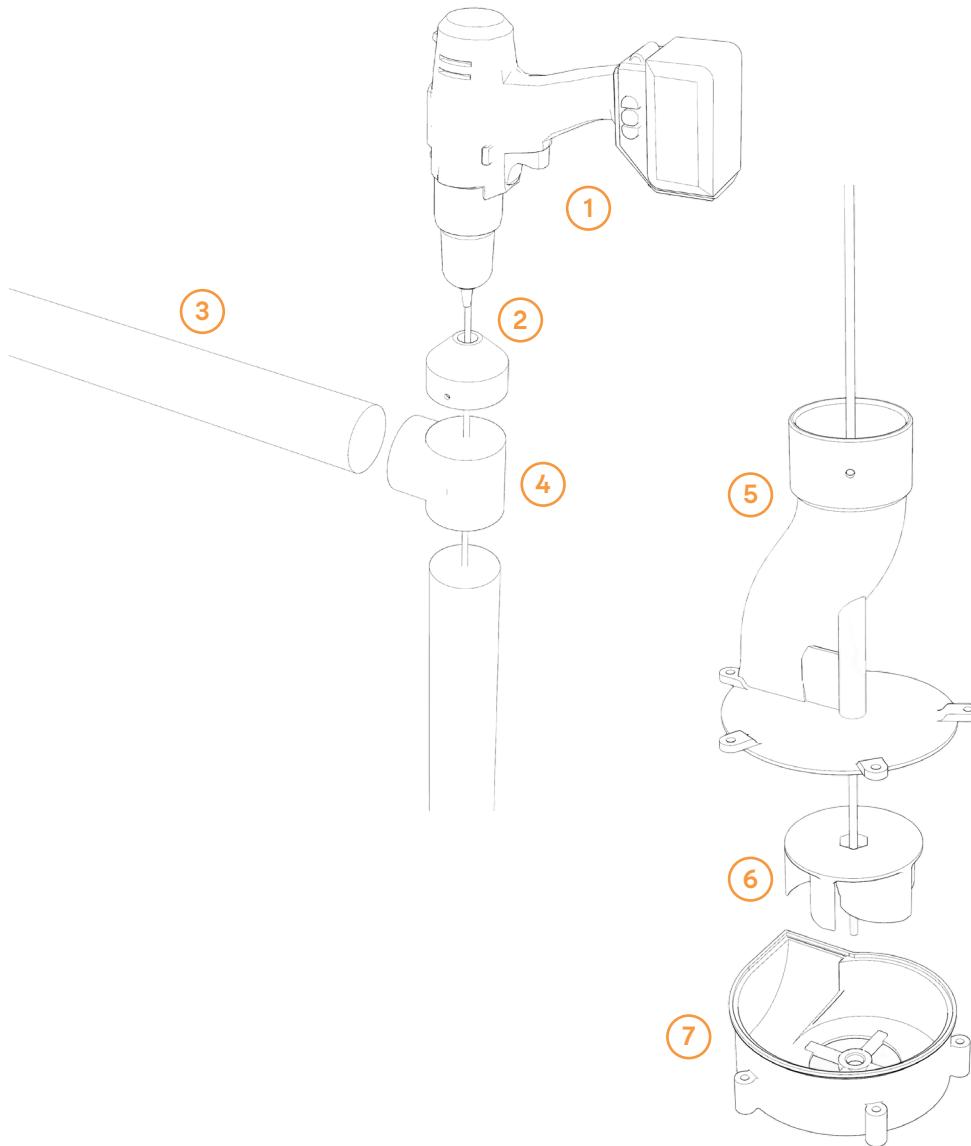
## 11.6 Main components

The system is composed of a limited number of components, each performing a clearly defined function within the overall assembly. The electric drill provides the rotational motion required for pump operation and allows the flow rate to be modulated directly by adjusting the rotational speed. The coupling ensures the transmission of motion from the drill chuck to the drive shaft, preventing slippage and misalignment.

The drive shaft transfers rotational motion to the impeller while keeping the motor at a safe distance from water. It is housed within a protective tube that also functions as a structural element. The pump body connects the drive section to the hydraulic section and is manufactured from water-resistant materials such as technical plastics or PVC. The impeller constitutes the actual pumping element, while the base with suction stabilises the system and enables water intake, potentially filtering out coarse impurities.

The main components of the system can be summarised as follows:

- 1 Electric drill (drive motor):** Provides rotary motion to the pump. The speed of the drill determines the flow rate: the more revolutions, the greater the amount of water pumped.
- 2 Drive shaft:** Transmits rotation from the drill to the impeller. It is contained in a protective tube to prevent infiltration and ensure safety and alignment.
- 3 Outlet pipe (discharge):** Conveys the pumped water to the outside or to the collection point. It can be flexible or rigid, made of PVC or rubber.
- 4 Connecting joint:** Connects the drill chuck to the drive shaft, ensuring a stable, slip-free connection. It can be rigid or flexible.
- 5 Extension tube / Pump body:** Connects the drive unit (drill) to the pumping unit (impeller). It also acts as a supporting structure and is made of water-resistant material.
- 6 Impeller (pumping element):** ConAs it rotates, it creates a central vacuum that draws in water and peripheral pressure that pushes it upwards. It is the main element of the system.
- 7 Base with support and suction:** Keeps the pump stable during immersion and allows water to enter. May include a protective grille against impurities.



## 11.7 Impeller sizing

The sizing of the impeller is closely related to the design flow rate and the required head. To ensure a flow rate of approximately 30 L/min with an effective head of 3 m, the impeller must be designed to operate efficiently at rotational speeds compatible with those provided by the electric drill.

From a design perspective, the impeller operates fully submerged during use and is manufactured from water-resistant plastic materials compatible with 3D-printing techniques. The geometry is intentionally simple and optimised for low head applications and continuous flow, thereby reducing the risk of cavitation and excessive hydraulic losses. The compact dimensions of the impeller also allow the overall pump body to remain small and lightweight, while limiting mechanical stresses on the drive shaft.

In summary, the impeller sizing is consistent with a design flow rate of 30 L/min and an effective head of 3 m. The impeller is designed to ensure a stable and continuous flow while avoiding cavitation phenomena and excessive losses.

Its main design characteristics are:

-  fully submerged operation,
-  construction in durable plastic or 3D-printable material,
-  a simple geometry optimised for low head conditions.

The choice of a compact impeller contributes to maintaining a compact pump body and reducing the load on the transmission shaft, supporting reliability and ease of use in emergency conditions.



### Pump sizing results:

#### Impeller

Optimal diameter: 80 mm  
 Number of blades: 3  
 Blade pitch: ~4 mm per revolution  
 Type: Axial impeller (semi-open propeller)

#### Design data

Flow rate  $Q=30$  L/min  
 Drill rotation  $N=1600$   
 Required head  $H=3$

#### Expected performance

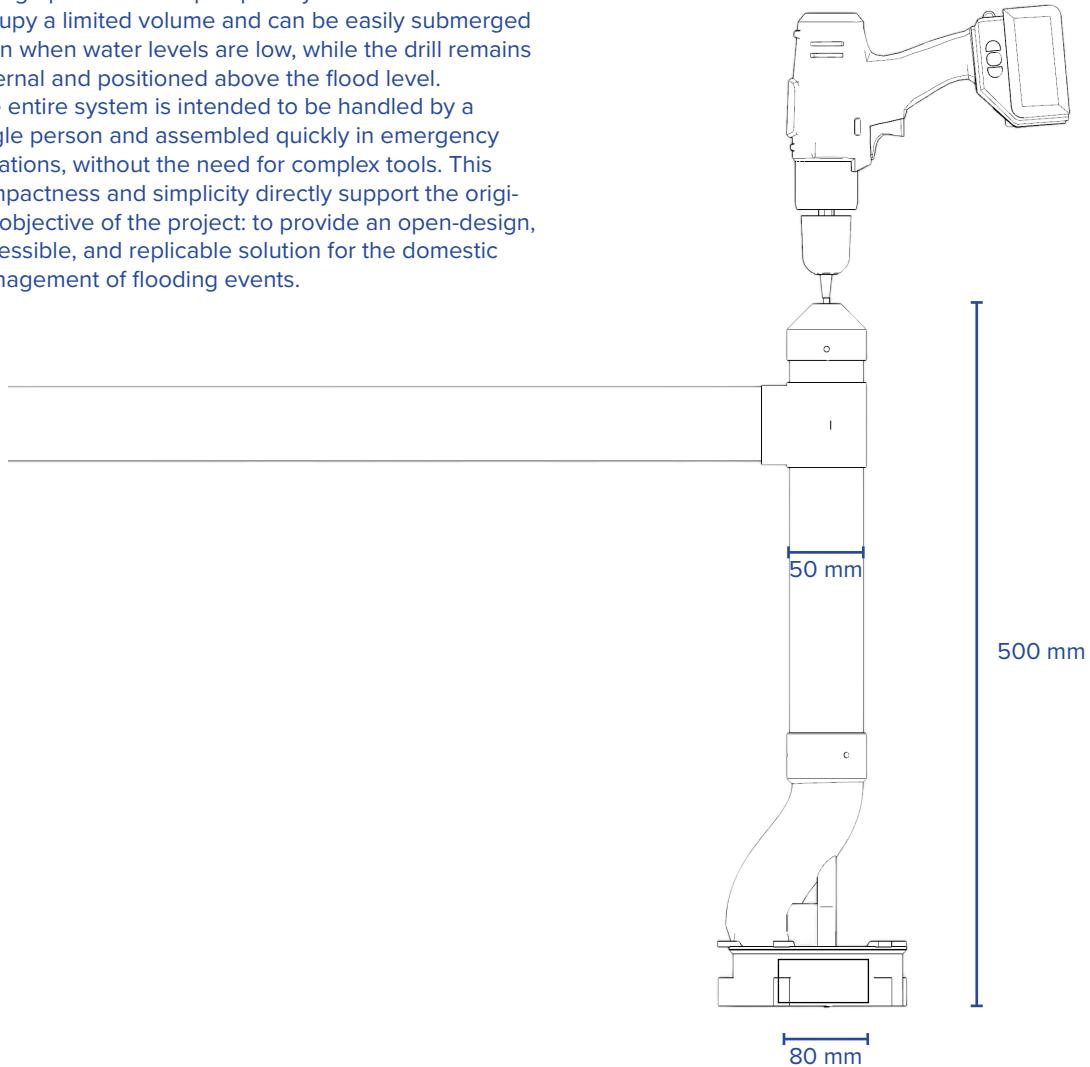
Flow rate: 30–33 L/min  
 Useful head:  $\approx 3$  m  
 Suitable for rapid drainage at low pressure

#### Motor (Drill)

Speed: 1600 rpm → adequate  
 Required torque:  $\approx 0.18$  N·m  
 Torque available from drill:  $\approx 1.0$  N·m → Ample safety margin

## 11.8 Estimation of overall dimensions

The overall dimensions of the pump are designed to ensure ease of transport, rapid installation, and safety during operation. The pump body and suction base occupy a limited volume and can be easily submerged even when water levels are low, while the drill remains external and positioned above the flood level. The entire system is intended to be handled by a single person and assembled quickly in emergency situations, without the need for complex tools. This compactness and simplicity directly support the original objective of the project: to provide an open-design, accessible, and replicable solution for the domestic management of flooding events.



12

# PROTOTYPING

ITERATIVE PROTOTYPING ENABLES TESTING AND PROGRESSIVE IMPROVEMENT OF THE PRODUCT. USER TESTING CONTRIBUTES TO THE DEFINITION OF THE FINAL MODEL.

## 12.1 Copenhagen FabLab

The entire development of the prototypes was carried out at the Copenhagen FabLab. The laboratory is a community-oriented digital fabrication center that provides access to cutting-edge machinery for rapid prototyping. Being part of the global FabLab network allowed for working within a collaborative environment, leveraging technical expertise and essential equipment for the open design experimentation conducted in this thesis.

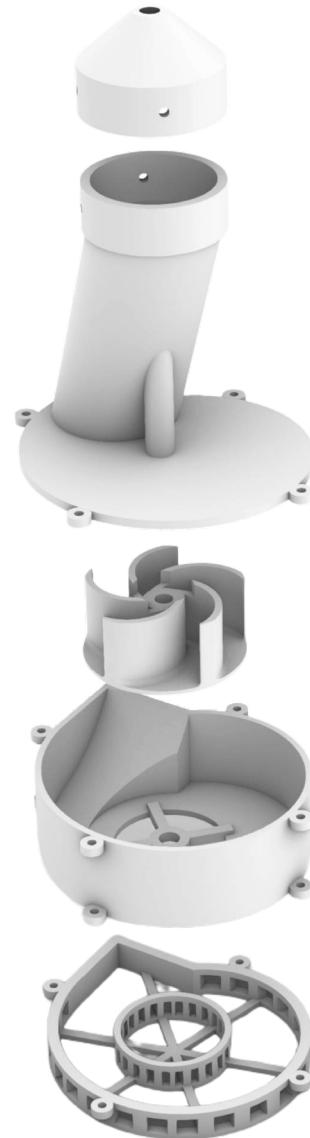


Photo by Agnese Baldoni, Copenhagen FabLab

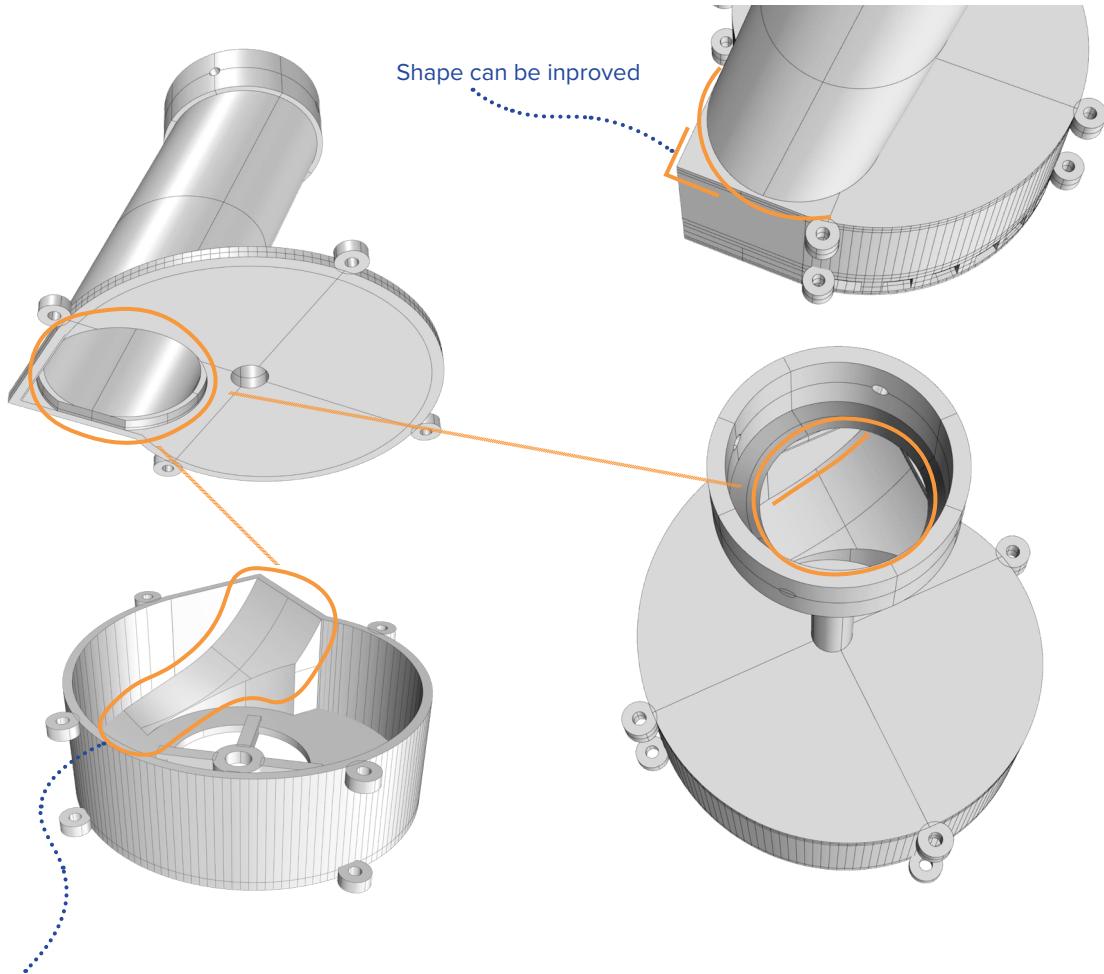


## 12.2 Prototype No. 1

The first prototype served to validate the general architecture of the system, which consists of five main elements: a perforated base for water intake, the main structure, the impeller, a connector to channel the flow upwards, and an upper cap to keep the threaded rod aligned with its axis.

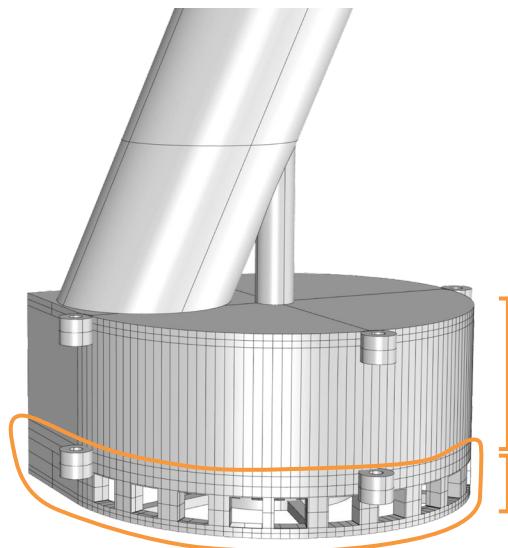
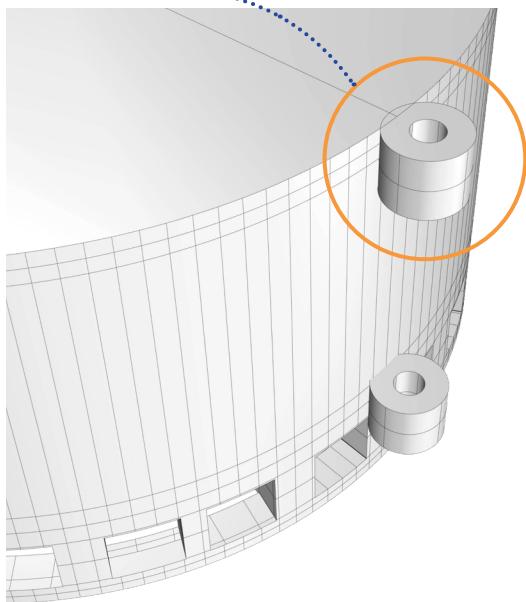


## Identified issues:



The slide/channel was incorrectly designed and does not match the shape of the connector tube.

The screw slots/rings are too fragile and break easily.



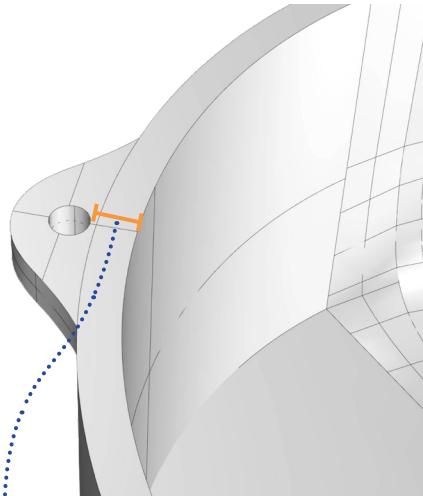
An additional component to channel water is unnecessary; this function should be integrated directly into the main structure.

## 12.3 Prototype No. 2

In the second version, significant structural changes were implemented. The main structure was redesigned to include a lower opening for fluid entry and a shaped internal channel to perfectly fit the new connector. The impeller was also modified in size to improve the flow rate.

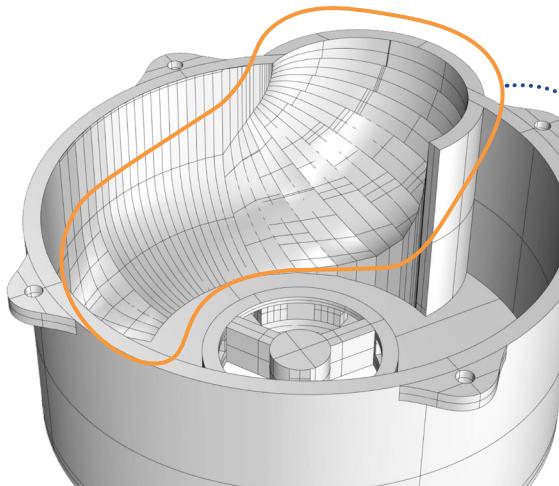
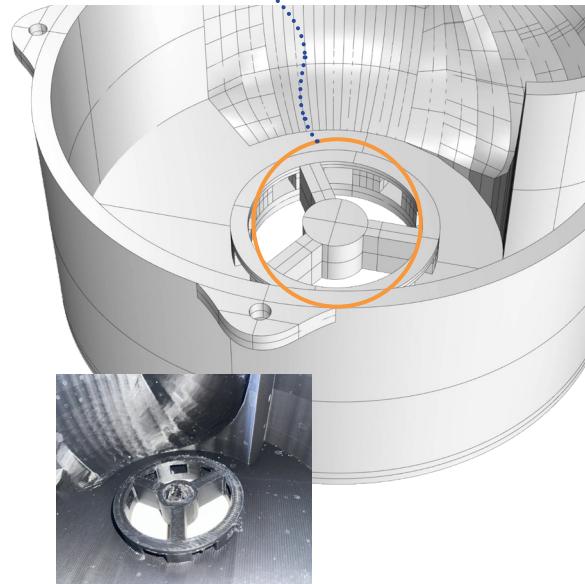


Identified issues:



The screw holes are too close to the edge, making it impossible to place the nut.

A central hole is required to keep the threaded rod perpendicular and properly aligned.

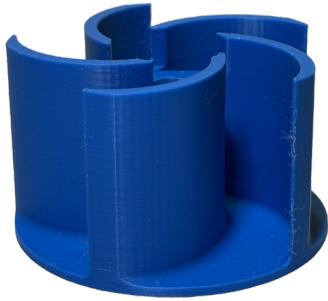


The mesh of the slide/channel is not smooth and needs refinement.

## 12.4 Prototype No. 3 (Final Model)

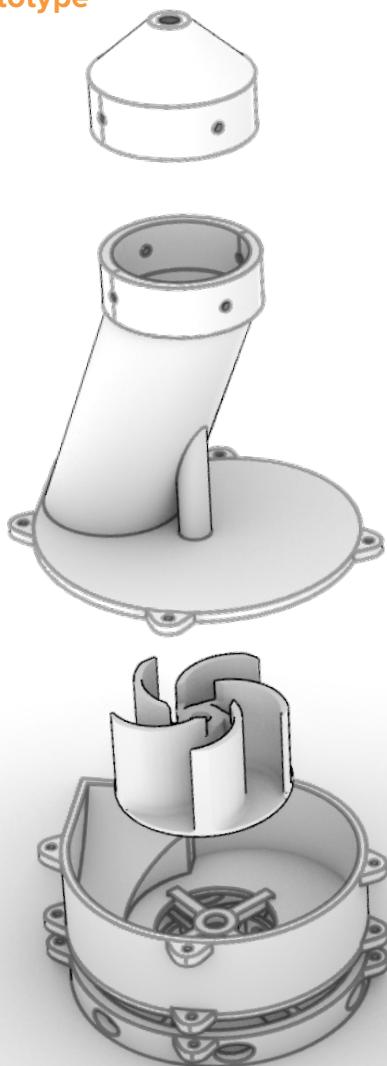
The third prototype represents the synthesis of previous optimizations. In addition to minor dimensional adjustments to resolve the mechanical tolerance issues of Prototype No. 2, the “Drilldrain” logo was engraved directly onto the main piece. This addition not only has aesthetic value, but also serves to identify the device within the neighborhood service system, strengthening the visual identity of the project.



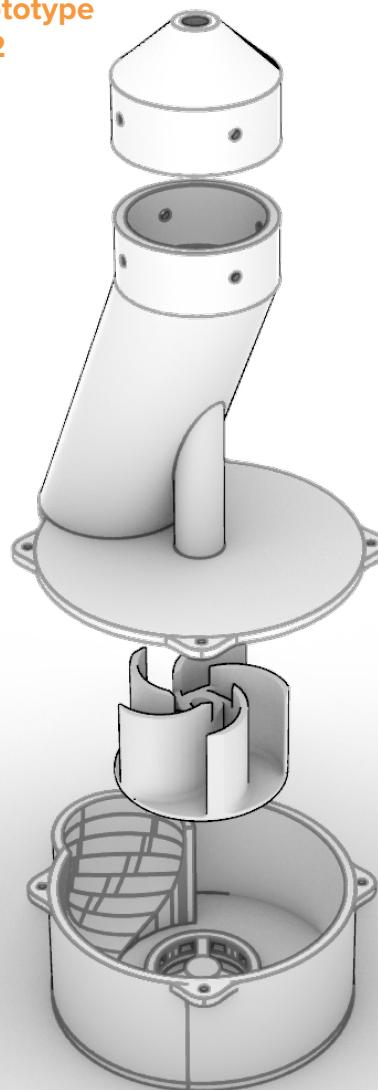


## Comparisons

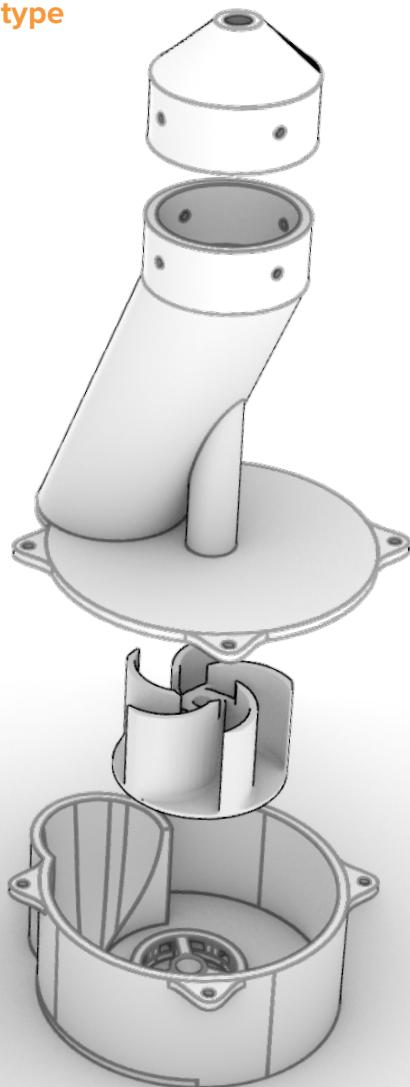
Prototype  
n. 1



Prototype  
n. 2

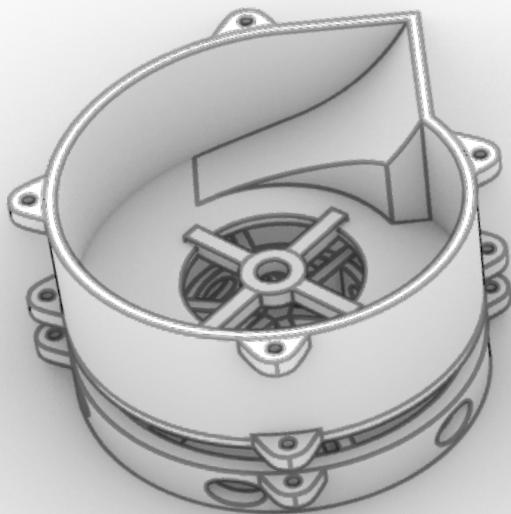


Prototype  
n. 3

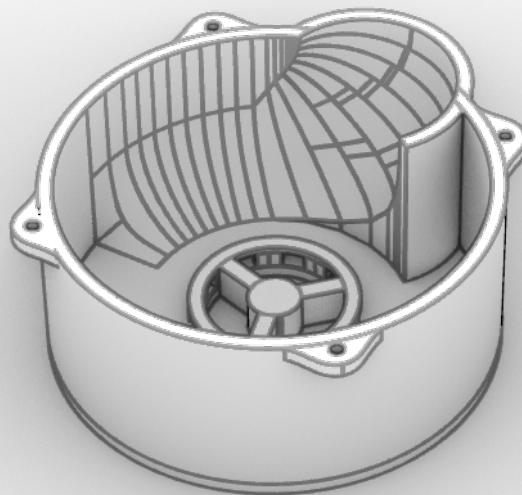


## Comparisons

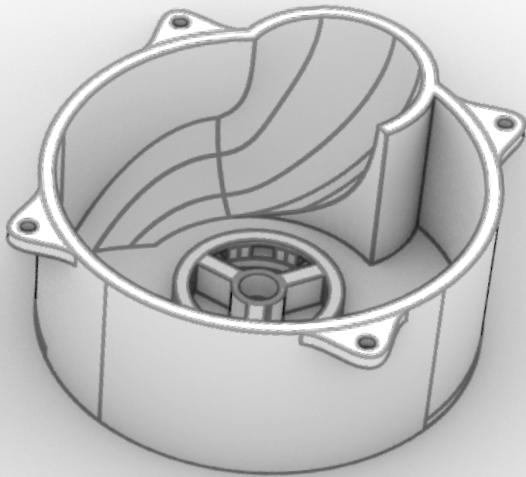
**Prototype  
n. 1**



**Prototype  
n. 2**

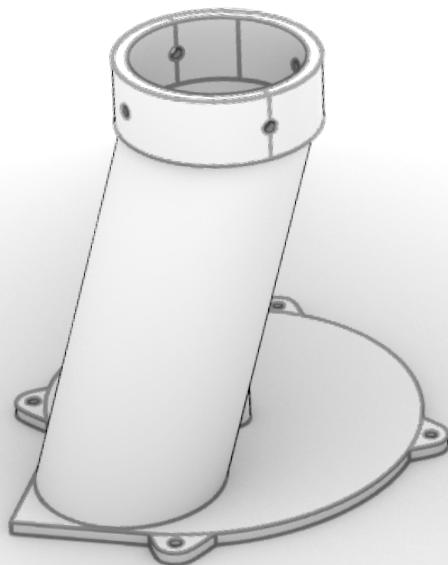


**Prototype  
n. 3**

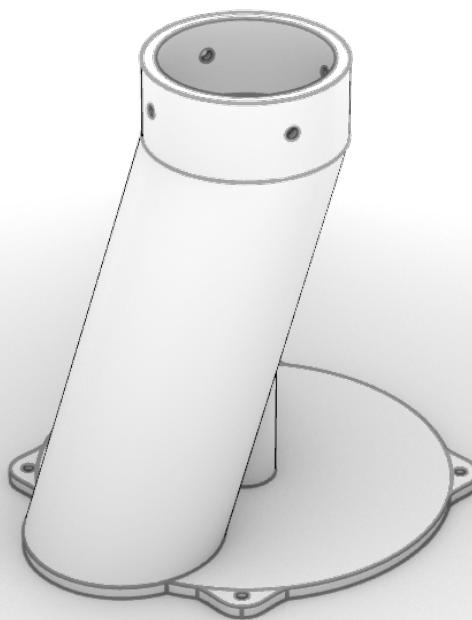


## Compvons

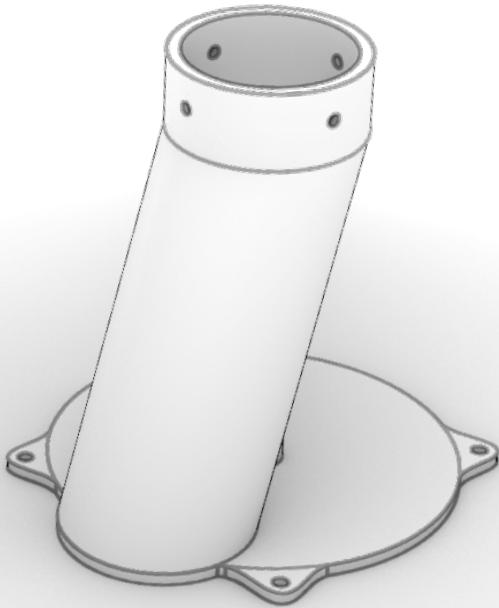
Prototype  
n. 1



Prototype  
n. 2



**Prototype  
n. 3**



## 12.5 Additional required components



### 8 screws

1.5 cm length, 0.5 cm diameter



### 4 bolts with nuts

2 cm length, 0.5 cm diameter



### Threaded rod

50 cm length



### Metal insert



**Hydraulic pipe**

5 cm diameter, 15 cm length



**Threaded rod**

5 cm diameter



**Electric drill**



**Flexible corrugated pipe**

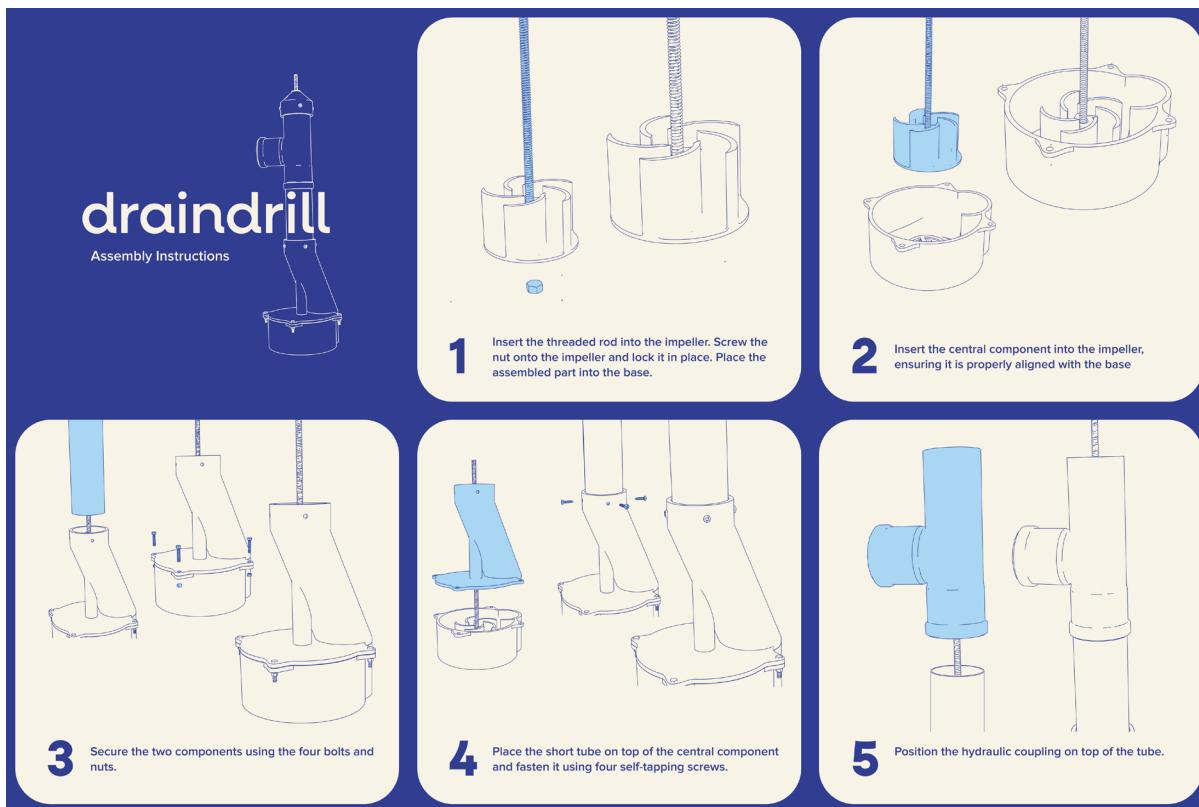
5 cm diameter

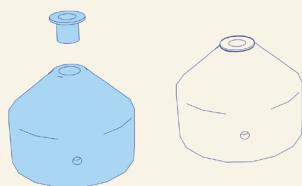
Vacuum cleaner hose can also be used

## 12.5 Assembly Instructions

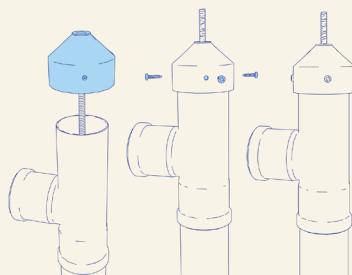
To ensure maximum accessibility, an illustrated instruction book was created to guide the user step-by-step, eliminating technical doubts during the assembly phase. In parallel, a tutorial video was produced to visually demonstrate the entire process, from connecting the drill to activating the water flow. These tools are essential to make the device usable independently by anyone, regardless of prior technical skills.

### Instruction sheet

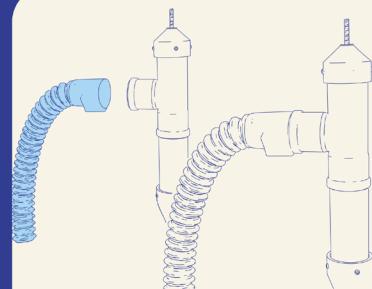




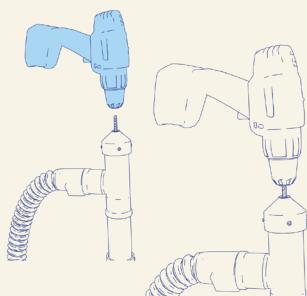
**6** Insert the metal insert into the cap.



**7** Place the cap onto the hydraulic coupling and secure it with four self-tapping screws.



**8** Attach the tube to the outlet opening.



**9** Mount the drill onto the threaded rod and tighten the chuck securely.

#### WHAT YOU NEED TO ASSEMBLE THE PUMP

##### Required Tools

Screwdriver

Power drill

Flexible corrugated pipe

diameter of 5 cm  
Vacuum cleaner hose can also be used

##### Components

8 screws

length of 1.5 cm and  
a diameter of 0.5 cm

4 bolts with nuts

2 cm in length and  
0.5 cm in diameter

Hydraulic pipe

diameter of 5 cm and  
a length of 15 cm

3-way hydraulic coupling

Triplet pipe with a  
diameter of 5 cm

Threaded rod

length of 50 cm

Metal insert

outer diameter of 18 mm, an inner diameter  
of 10 mm, and a height of 12 mm

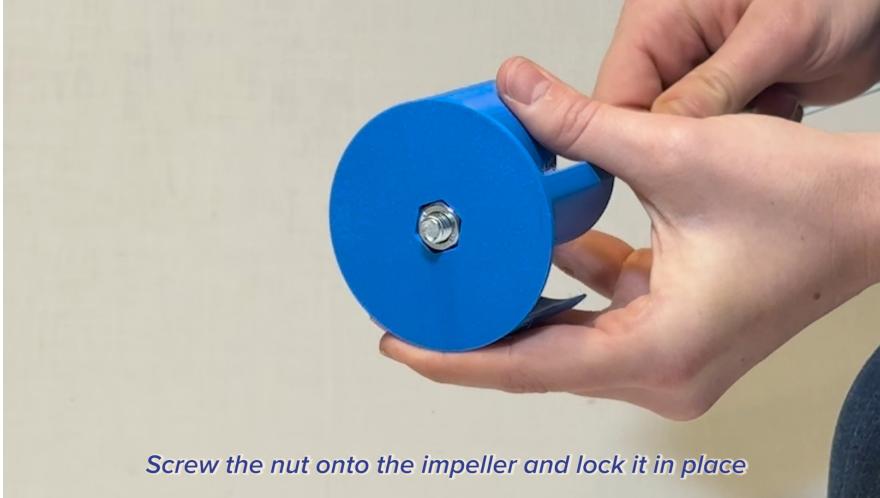
#### ASSEMBLY TIPS

- Adhesives: Use a multi-material glue to firmly secure parts together if necessary.
- Sealing: You may use gaskets or seals to minimize water leakage.
- Pre-drilling: To make driving the self tapping screws easier, drill a small pilot hole into the hydraulic pipe first.

#### HOW TO USE IT

- Grip: Firmly hold the pump by the hydraulic coupling.
- Submerge: Immerse the lower part of the device into the water.
- Operate: Start the drill at high power and begin draining the water!

## Instructional video





## 12.6 Functional Testing

**Experimental Objectives** This chapter describes the testing procedures conducted on the developed hydraulic pump prototype. The primary objective of the test is to determine the volumetric flow rate and analyze the dynamic behavior of the system as the head varies, referring to the geometric height difference between the suction point and the water discharge point. **Experimental Setup and Methodology** To validate performance, a dual-tank test bench was set up.

### Setup Double Tank Configuration:

- ④ Source tank (supply).
- ④ Prismatic measuring tank (Control volume: 50 Liters).

### Instrumentation and Monitoring:

- ④ Use of a fixed camera aimed at the receiving tank.
- ④ Precise timing through video analysis to determine the exact filling time.

### Objective

- ④ Map the pump behavior across 3 head scenarios (elevation difference).



### Case A: Test at equal hydraulic level (0 m)

Case A: Zero head (Equal hydraulic level) In this configuration, the discharge tube was placed at the same elevation as the pump. This condition represents the standard performance benchmark.

### Configuration:

Discharge pipe and pump at the same elevation.

### Data recorded:

- 🕒 Filling time (50L): 136 seconds
- 🕒 Volumetric flow rate: 22.0 Liters per minute.

### Analysis:

Represents the standard operating benchmark of the prototype without external gravitational influences.



## Case B: Negative head

Case B: Negative head (Discharge 1 meter lower) In this scenario, the discharge tube was positioned 1 meter below the pump level. The system benefits from the gravitational effect that facilitates the fluid outflow.

### Configuration:

The discharge pipe was positioned 1 meter below the pump level.

## Data recorded:

📉 Estimated flow rate: 26.5 Liters per minute.

### Analysis:

Approx. 20% increase in flow rate compared to the base case.

The favorable hydrostatic pressure assists the outflow, reducing the effort on the drill motor.



### Case C: Positive head

Case C: Positive head (Lifting 1 meter higher) In this configuration, the pump must overcome the force of gravity to lift the water to an elevation 1 meter higher than the suction point.

### Configuration:

Discharge pipe and pump at the same elevation.

### Data recorded:

📉 Estimated flow rate: 17.2 Liters per minute.

### Analysis:

Approx. 22% reduction in flow rate compared to level operation.

The need to overcome gravitational potential energy results in increased resistance.



## Results and Discussion

Results and Discussion The data obtained allow for the prediction of the system's operational capacities over extended periods of time, which is useful for defining the prototype's fields of application. The following table summarizes the volumes of water moved based on the duration of operation.

The tests demonstrate the full functionality of the prototype. The variation in flow rate relative to the discharge elevation correctly follows the laws of fluid dynamics. The system proves capable of moving over half a cubic meter of water (516–795 liters) in thirty minutes of continuous operation, confirming the effectiveness of the pump design for both practical and thesis purposes.

### Volumetric handling capacity based on head levels

<i>Scenario</i>	<i>Head (m)</i>	<i>Flow Rate (L/min)</i>	<i>Volume in 30 min (L)</i>	<i>Variation %</i>
Case A	0 m	22.0	660	Benchmark
Case B	-1 m	26.5	795	+20.4%
Case C	+1 m	17.2	516	-21.8%

## Validation of Objectives (Targets vs. Results)

### Hydraulic Performance

TARGET: 20–40 l/min.

RESULT: The flow rate of 22 l/min (base) and 26.5 l/min (negative pressure) falls perfectly within the useful range for small drainage systems.

### Portability and Usability

TARGET: Weight < 1 kg.

RESULT: The absence of an integrated motor drastically reduces the weight of the kit. Compact dimensions for storage in small domestic spaces.

### Affordability and Sustainability

TARGET: Material cost < £30.

RESULT: Hacking philosophy: 60% savings compared to commercial pumps by eliminating the dedicated electrical component.

Components: Use of standard fittings and 3D-printable shell (low-cost repairability).

## 12.7 User Testing

### Evaluation of User Experience (User Testing)

In this phase of the research, the focus shifted from purely technical validation to the verification of real-world usability. Two qualitative tests were conducted with different demographic profiles to analyze the ergonomics, perceived safety, and clarity of the system.

### Methodology and Tools

The Evaluation Sheet To collect data, an Experiential Evaluation Sheet was designed, consisting of key indicators rated on a scale of 1 to 5 (1: Very poor, 5: Excellent). The chosen indicators aim to measure both practical effectiveness and the user's psychological burden.

Evaluation Indicators:

-  **Assembly understanding:** Ease of coupling the drill chuck with the pump shaft.
-  **Grip ergonomics:** Comfort in holding the system during operation.
-  **Operational stability:** Evaluation of vibrations and the tendency for misalignment.
-  **Risk perception:** Sense of safety regarding the proximity between water and electrical components.
-  **Ease of maintenance:** Judgment on the speed of intervention in case of an impeller clog.
-  **Social utility:** Judgment on the proposed neighborhood sharing system.

## Alessandra (55 years old)

### Profile

Expert in household management, she looks for reliability, robustness, and long-term psychological safety.

### Performance della Scheda (Scale 1-5):

Assembly comprehension: 3/5

Grip ergonomics: 4/5

Operational stability: 4/5

Risk perception: 1/5

Ease of maintenance: 1/5

Social utility: 5/5

### Qualitative Feedback

Alessandra's experience was characterised by excellent handling of the device, but also by significant safety concerns. In particular, the proximity of the water flow to the drill motor generated strong apprehension: "Seeing the water flowing so close to the drill motor scared me; if a tube came loose, the water could end up in the tool's air vents."

Alessandra also highlighted maintenance-related issues. When the impeller slightly shifted, the operation required to reposition it, unscrewing four screws, proved to be long and cumbersome, making it unsuitable for an emergency situation. Finally, she reported discomfort caused by the prolonged noise of the drill during use and the rapid battery drain, which lasted approximately 30 minutes during testing.



Didascalìa  
Didascalìa

## Virginia (25 years old)

### Profile

Highly educated, living in an urban context, with limited familiarity with power tools and mechanical maintenance.

### Performance della Scheda (Scale 1-5):

Assembly comprehension: 5/5

Grip ergonomics: 2/5

Operational stability: 2/5

Risk perception: 4/5

Ease of maintenance: 2/5

Social utility: 5/5

### Qualitative Feedback

Virginia completed the assembly quickly, confirming the intuitiveness of the system's design. However, she highlighted a significant issue related to the physical effort required during use. In particular, she observed: "The system is powerful, but after a few minutes I started to feel tension in my wrist. The drill tends to rotate in the opposite direction of the pump, and keeping them aligned requires constant force that not everyone might have in a moment of panic."

She also pointed out that the lack of a clear handle on the pump body makes it unclear how the entire system should be properly supported, generating ambiguity in use and potential operational difficulties.



Didascalìa  
Didascalìa

## Guidelines for Prototype Optimization

From the cross-analysis of the feedback, the following guidelines were drafted for the development of the next version of the device:

-  **Simplification of Maintenance:** Replace the four-screw casing attachment with a snap-fit or bayonet locking system. This would allow the impeller to be cleared in seconds without external tools.
-  **Ergonomic Interface:** Design a dedicated handle or a stabilization base. This would help users, like Virginia, keep the system aligned without straining the wrist and would immediately clarify how to hold the device.
-  **Safety and Shielding:** Implement a water flange, splash guard, between the pump body and the drill chuck to protect the electric motor and increase the safety perceived by the user, as reported by Alessandra.
-  **Power and Noise Management:** Include clear visual instructions on the need to maintain high rotation speeds for priming. Study materials for the casing that can dampen prolonged noise and vibrations.
-  **Energy Continuity:** Since the drill battery provides about 30 minutes of autonomy under load, the “neighborhood service” must provide corded drills or pre-charged replacement battery kits to ensure the management of extensive flooding.

Although the pump met the hydraulic requirements, user testing demonstrated that the project’s success depends on reducing psychological and physical barriers. The excellent score received for “Social Utility” by both profiles confirms, however, that the direction of the shared neighborhood service is the correct response to the community’s needs.

## 12.8 Final model and design evolution perspectives

The final model presented in this thesis represents the most advanced iteration of the research and development process. The device has been optimized to balance maximum hydraulic efficiency with ease of reproduction through 3D printing. In its current configuration, the pump has fully met the predetermined design requirements, demonstrating a constant drainage capacity and universal compatibility with commercial electric drill chucks.

However, as emerged from the User Testing phase described in the previous paragraph, the design remains an “open” system susceptible to further evolution. Although the model satisfies the technical requirements of the thesis, future development (post-thesis) should integrate user feedback regarding grip ergonomics, splash shielding, and the simplification of the casing closure. The value of the project lies precisely in this evolutionary nature, typical of hacking design, where the prototype is not an end point but a solid foundation for collective implementation.

## 12.9 Open Access License

In accordance with the open design approach adopted throughout the entire thesis process, the project is released under a Creative Commons Open Access license, allowing for free consultation, reproduction, and adaptation. The device and the related design documentation are available on major open access prototyping platforms to encourage dissemination, replicability, and collaborative improvement by communities, makers, and professionals. This choice is intended to strengthen the project's accessibility and its potential social impact, in line with the principles of sharing, transparency, and participation inherent to open design.

**The device can be accessed on Printables.com at this link:** <https://www.printables.com/model/1573488-drain-drill-drill-powered-water-pump>



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Remix Culture allowed

Commercial Use

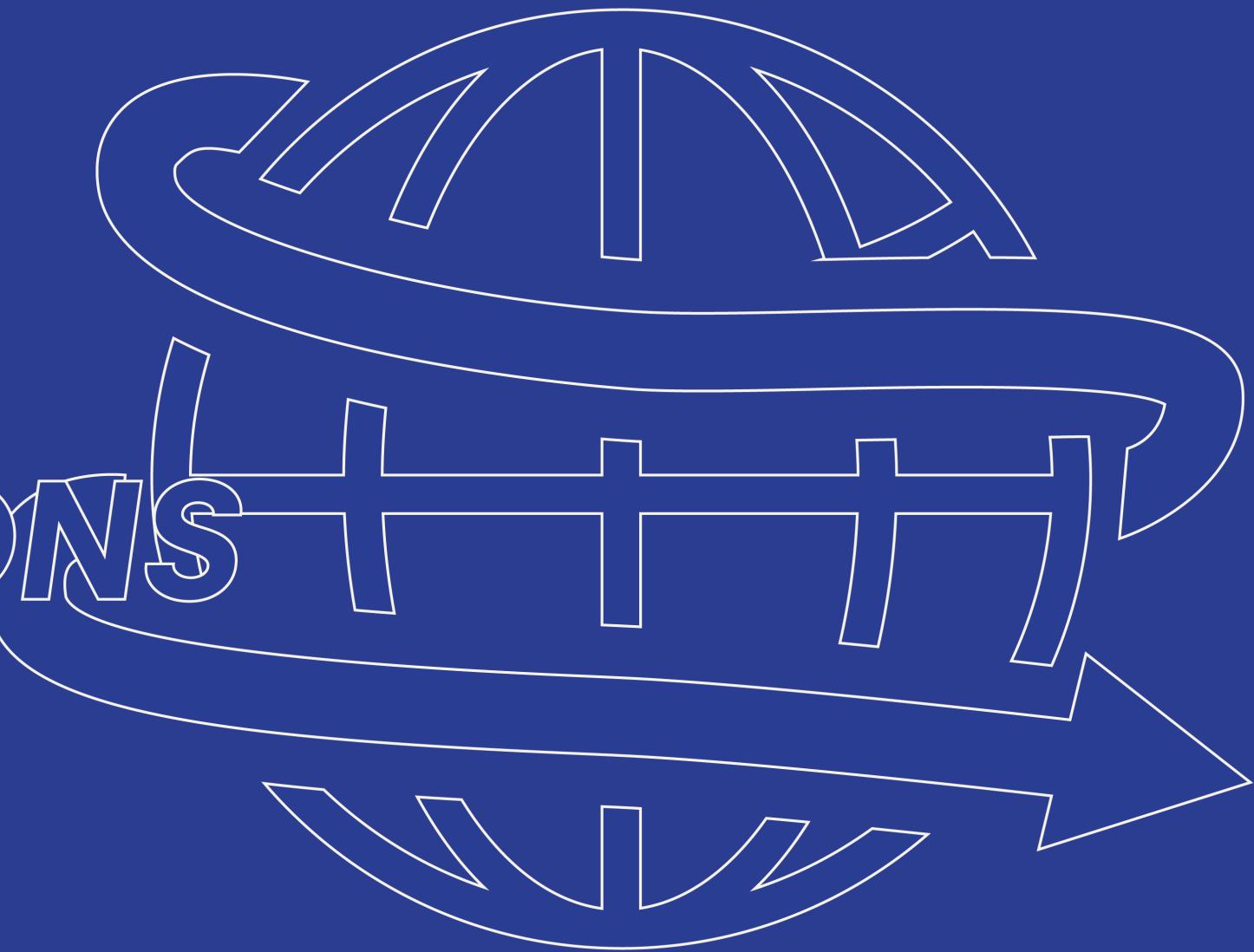
Free Cultural Works

Meets Open Definition

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***FINAL***  
***CONSIDERATIO***



# 12

# CONCLUSIONS

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PROJECT OUTCOMES HIGHLIGHT THE POTENTIAL OF INTEGRATING OPEN DESIGN, PRODUCT DESIGN, AND SERVICE DESIGN TO SUPPORT COMMUNITY RESILIENCE. FUTURE DEVELOPMENTS AND SCALABILITY ARE OUTLINED.

### 13.1 Project results and outcomes

The path of research, analysis, and practical experimentation conducted within this thesis has led to the definition of a concrete, tangible, and, above all, systemic response to the issue of domestic water micro-emergencies. The goal achieved should not be interpreted exclusively through the “pump” as a physical artifact or mechanical component; the most significant result is, in fact, the validation of a design paradigm. The project has demonstrated how Open Design methodologies can act as a catalyst to demo-

cratize access to civil protection tools that, until now, have remained the exclusive domain of professionals or institutional bodies. Through an hacking design approach, it was possible to convert a common power tool already widely found in homes, the electric drill, into an effective emergency device, drastically lowering the barriers to adoption.

From a strictly technical perspective, the data collected during the testing phase provided solid empirical evidence: the final prototype is capable of generating a volumetric flow rate of approximately 22 liters per minute under zero head conditions. Projecting

this data over a prolonged period of use, the system is capable of moving over 600 liters of water in just thirty minutes. Such performance confirms the success of the hydraulic sizing carried out at the Copenhagen FabLab, verifying the reliability of the components produced through additive manufacturing.

However, beyond the technical data, an essential result of this work lies in the high educational and personal value derived from conducting the thesis in Copenhagen. Operating in Denmark allowed for an immersion in a design culture deeply imbued with pragmatism, sustainability, and civic sense. The opportunity to work within the Copenhagen FabLab offered me a privileged observation point on the power of digital fabrication as a tool for social inclusion.

Exposure to the Danish model, where design is seen as a service to the community and innovation often arises from collaborative and “bottom-up” approaches, was the spark that transformed an engineering challenge into a proposal for social infrastructure. This international experience has enriched my professional background with a cosmopolitan vision, teaching me the importance of designing not only for the individual, but for the resilient collective.

In the final analysis, the project does not limit itself to providing an object, but delivers an infrastructure of resilience to the community. The “Drilldrain” kit becomes a tool of empowerment for the citizen, who stops being a passive subject waiting for external aid to become an active part of a local defense strategy. This solution enables a timely and collective reaction, transforming the emergency into an opportunity to strengthen neighborhood ties, promote mutual support, and stimulate a renewed shared responsibility toward the protection of the territory.

## 13.2 Product positioning within benchmarking

To fully understand the innovative value of Drilldrain, it is necessary to contextualize it within the current market of drainage solutions, where the project fills an operational gap that could be defined as an “immediate emergency niche.” The benchmarking analysis conducted during the research highlighted a polarization of the sector into three macro-categories, each of which presents insurmountable structural limitations in a sudden flood scenario:

- **Industrial water pumps and professional motor pumps:** These devices represent the standard for managing large volumes of water. However, their effectiveness is limited by prohibitive purchase costs for the individual citizen, large dimensions, and technical complexity requiring constant maintenance and specific skills for startup. Furthermore, the logistics related to their deployment mean that these machines often arrive at the emergency site hours late, when the water damage is already consolidated.
- **Domestic submersible pumps:** Although they are efficient and relatively common tools, their functionality is strictly tied to the presence of the electrical grid. In cases of severe flooding, power is often cut off for safety reasons, rendering these pumps completely inert. Additionally, they require fixed installation in drainage pits or a pre-existing configuration that is not always available in unexpectedly affected rooms.
- **Manual and archaic solutions (buckets, rags, brooms):** These represent the only immediate resource for the majority of the population. Although they are universally accessible tools, they are entirely insufficient in terms of flow rate, as the work is physically exhausting, slow, and incapable of countering a constant influx of water, often leading residents to a state of frustration and helplessness. In this scenario, Drilldrain emerges as a disruptive “third way,” positioning itself exactly at the center of the pyramid of existing solutions. The device borrows mechanical power from a technology already present

in almost every home, the drill, offering the performance of a small electric pump without the cost and bulk of a dedicated motor.

The true competitive advantage over commercial competitors lies in the combination of immediate availability and open-source nature. While an industrial product is a closed object, often difficult to find during peak demand, such as pre-flood “panic buying,” Drilldrain is a shared infrastructure. It is designed to be an integral part of a “neighborhood survival kit,” where repairability and replicability are guaranteed by the community itself.

The positioning of Drilldrain is therefore not only commercial but strategic-political, as it reduces production costs to a fraction compared to market alternatives and transforms an individual consumer good into a resilient common good, capable of evolving and improving through the collective contribution of makers and residents.

### 13.3 Product evolution after user testing

Listening to the users, Virginia and Alessandra, represented the moment of confrontation between design theory and operational reality. Although the “Final Model” presented in this thesis satisfies the academic objectives, the tests have outlined the roadmap for the future “Drilldrain 2.0” version.

Post-thesis evolution will need to focus on three human and technical directions:

Ergonomics of the support: It emerged that the manual control of the drill-pump combination is fatiguing.

Future evolution involves the integration of a “coupling slide” or a stabilizing base that allows the system to be placed on the ground, transferring the weight and vibrations away from the user’s arms.

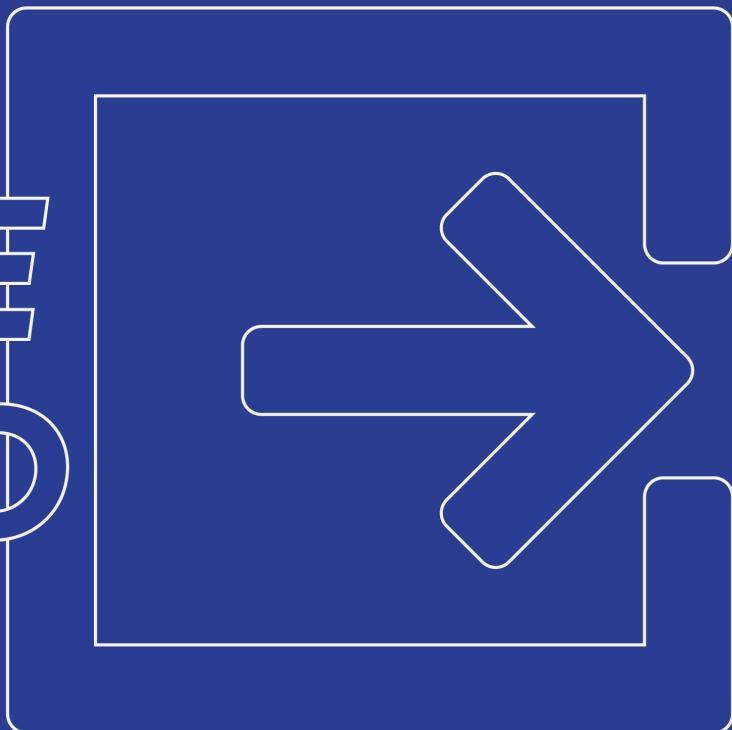
Safety interface: The fear of water splashes reported by users suggests the addition of a transparent physi-

cal protection between the pump body and the chuck. Psychological safety is as fundamental as mechanical safety in contexts of panic.

“Fast-Access” maintenance: Switching from the current four closing screws to a snap-clip system will allow the impeller to be inspected in seconds, solving the problem of mechanical blockages without having to search for tools, such as screwdrivers, during flooding.

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***THE  
END***





## 13.4 Bibliography and references

### Print and Academic References

Afedzie, R., & McEntire, D. A. (2010). Rethinking disasters by design. *Disaster Prevention and Management*, 19(4), 481–493. <https://doi.org/10.1108/09653561011070354>

Anderson, C. (2012). *Makers: The new industrial revolution*. Crown Business.

Antonelli, P. (2011). *Design and the elastic mind*. Museum of Modern Art.

Bianchini, M., Bolzan, S., & Maffei, S. (2021). *Design for survival: Approaches and practices in crisis contexts*. Politecnico di Milano.

Cappelli, F., Monti, M., & Raitano, M. (2021). The trap of climate change-induced “natural” disasters and inequality. *Ecological Economics*, 187, 107102. <https://doi.org/10.1016/j.ecolecon.2021.107102>

Clarke, B., Otto, F., Stuart-Smith, R., & Harrington, L. (2022). Extreme weather impacts of climate change: An attribution perspective. *Environmental Research Letters*, 17(2), 024021. <https://doi.org/10.1088/1748-9326/ac4a3d>

De Angelis, A. (2022). *La sopravvivenza durante l'emergenza: Il contributo dell'industrial design*. FrancoAngeli.

Di Maio, P. (2019). An open ontology for open source emergency response systems. *International Journal of Information Management*, 46, 140–149. <https://doi.org/10.1016/j.ijinfomgt.2018.11.015>

Izumi, T., Shaw, R., Djalante, R., Ishiwatari, M., & Komino, T. (2019). Disaster risk reduction and innovations. *Progress in Disaster Science*, 2, 100033. <https://doi.org/10.1016/j.pdisas.2019.100033>

Manzini, E. (2015). *Design, when everybody designs: An introduction to design for social innovation*. MIT Press.

Papanek, V. (1984). *Design for the real world: Human ecology and social change*. Academy Chicago Publishers.

Pietroni, L., Mascitti, J., Galloppo, D., Paciotti, D., & Di Stefano, A. (2022). Un approccio sistemico al design per la sopravvivenza. *MD Journal – Design for Survival*.

Schweizer, P.-J., & Renn, O. (2019). Governance of systemic risks for disaster prevention and mitigation. *Risk Analysis*, 39(5), 1040–1054. <https://doi.org/10.1111/risa.13244>

Thackara, J. (2015). *How to thrive in the next economy: Designing tomorrow's world today*. Thames & Hudson.

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## Digital Resources and Online Documentation

Copenhagen FabLab. (n.d.). Technical specifications and prototyping laboratory community. <https://fablab.kk.dk/>

Creative Commons. (n.d.). Open access license definitions (CC BY-NC-SA 4.0). <https://creativecommons.org>

Danish Coastal Authority. (2020). Guide to dynamic planning of climate adaptation and management of the risk of flooding in municipalities. <https://kyst.dk>

Danish Emergency Management Agency. (2021). Crisis management in Denmark. <https://www.brs.dk>

DR News. (2025). Citizens in Kerteminde self-financing storm surge protection. <https://www.dr.dk>

Fab Foundation. (n.d.). Global digital fabrication resources and documentation. <https://fabfoundation.org>

Intergovernmental Panel on Climate Change. (n.d.). Reports on the impacts of climate change and global flooding. <https://www.ipcc.ch>

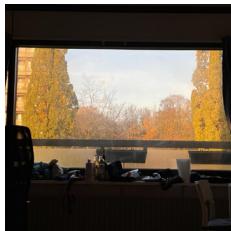
PreventionWeb. (n.d.). Climate risk and flooding data for Denmark. <https://www.preventionweb.net>

Prusa Research. (n.d.). Technical support for 3D printing settings (PrusaSlicer & MK3S). <https://www.prusa3d.com>

Technical University of Denmark. (n.d.). Climate adaptation and flood risk research. <https://www.dtu.dk>

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