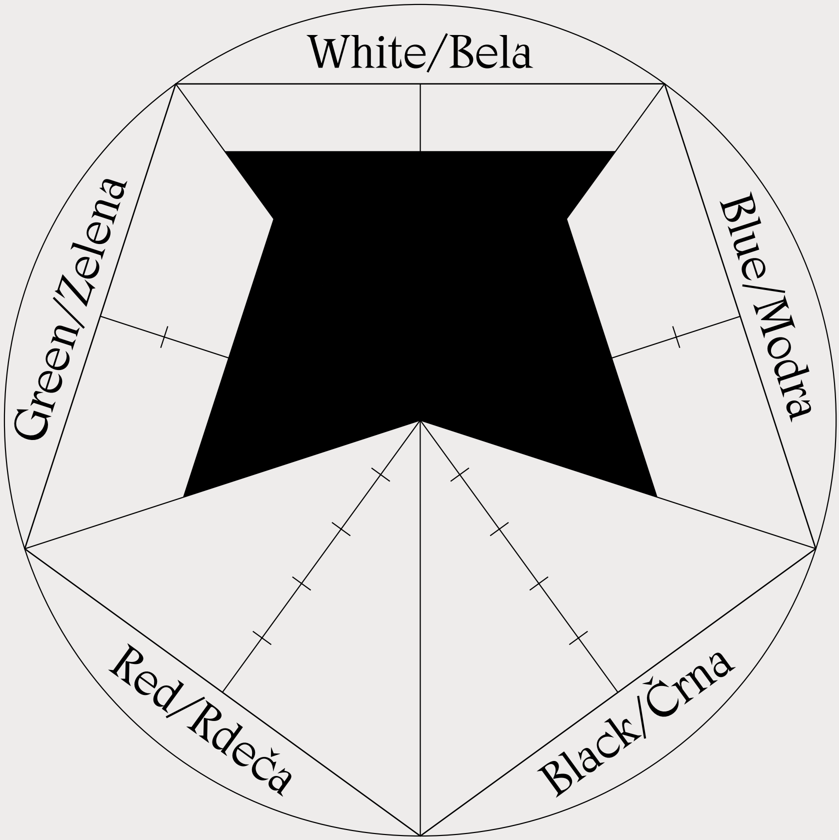
CASE STUDY

7

ŠTUDIJA PRIMERA

Mapping

Mapiranje



WHITE

health, safety, community, equality

BLUE

awareness-raising, knowledge, new technologies

BLACK

RED

GREEN

regeneration, wisdom, tradition

BELA

zdravje, varnost, skupnost, enakopravnost

MODRA

ozaveščanje, znanje, nove tehnologije

ČRNA

RDEČA

ZELENA

regeneracija, modrost, tradicija

WHITE BLUE BLACK RED GREEN

PLANNING PROPOSALS AND SOLUTIONS TO RAISE AWARENESS AND ALLEVIATE THE PROBLEM OF WATER POLLUTION IN LOCAL COMMUNITIES WITH THEIR OWN WATER CATCHMENT

AUTHORS	Žan Girandon, Pia Groleger and Luka Pleskovič
THEORETICAL MENTOR	Assoc. Prof. Dr. Barbara Predan
PRACTICAL MENTOR	Prof. Barbara Prinčič, MSc
CO-MENTOR	Prof. Jure Miklavc
STUDY PROGRAMME AND COURSE	Industrial Design and Applied Arts, Industrial Design
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As many as 20% of the Slovenian population live in areas that are not part of the public water supply system, which means that the water catchments do not undergo regular sampling. This is especially the case in the more mountainous regions, where water needs to be boiled or purified in some other way. The location under investigation is at the Lipnik spring, within Triglav National Park, where elevated levels of the E. coli bacteria have been detected. The goal of the project was to develop a water filtration solution for use in remote locations that would be based on vernacular principles while using new technologies.

STARTING POINT

BIO27 and the water environment

The choice of the subject for this master's thesis was prompted by the open call in 2022 for applications for the Production Platform of the *Biennial of Design 27* (BIO27), with the overarching theme *Super Vernaculars – Design for a Regenerative Future*. Five themes were available for the projects in the production platform. The one authors ended up choosing was *Water – Designing a Biovernacular*, as they believed it was the one that best fit the design approaches, offering various possibilities for responding through product and sustainable design.

In the context of the environmental crisis, a water-related issue is a very relevant topic to address, as the rise in the Earth's average temperature is having a major impact on the water environment around the world. *Stockholm Resilience Centre*, under the leadership of the scientist Johan Rockström, developed the concept of the nine planetary boundaries (2015) within which humanity can continue developing and thriving for future generations. Pushing past these boundaries increases the risk of triggering irreversible environmental changes. One of these boundaries has to do with fresh water consumption and the water cycle at the global level. Due to water consumption and pollution, as well as climate change, which itself has a strong impact on the hydrological systems, we have already approached the planetary boundary associated with the water cycle (Stockholm University). Agricultural and industrial pollution, excessive water use in agriculture, population growth and general climate crises increasingly threaten the water systems that sustain habitats and feed the growing population. Lakes, rivers and aquifers are drying up or becoming too polluted to be used. More than half of the world's marshlands have disappeared. Agriculture uses more water than any other human activity, and much of it is wasted through inefficiency. As a result, around 1.1 billion people worldwide have no access to water, while a total of 2.7 billion people face water scarcity for at least one month of the year. Even more frightening is the fact that by 2050, more than half a billion people will suffer due to water-related catastrophes (World Wildlife Fund). Although Slovenia has abundant water resources, it also faces water environment-related issues.

CRITICAL EXAMINATION OF THE ISSUE

Slovenia has clean water – or does it?

As the authors of the master's thesis point out, a holistic view of the complex situation of the local water environment required research into the general and specific characteristics of the water environment in Slovenia, as well as an in-depth understanding of the vernacular context and examples of good practice. The experts interviewed pointed out that problems with the water environment are due to a lack of understanding of the topics of water and environmentalism. The first problem is that in Slovenia, we associate the availability and quantity of water with its quality, even though water quality is an issue in certain parts of the country. In other words, there is a perception in the Slovenian collective consciousness that our water is of excellent quality, even though, in terms of many parameters, this is not the case. The second problem with our fundamental perception of water is the global water cycle—more precisely, the fact that the water cycle is a global process. Biologist Mihael J. Toman points to the lack of understanding that "local pollutants affect the water cycle virtually in its entirety" and that "polluting the land also places a heavy pollution burden on water" (National Geographic Slovenia 2021). Toman goes on to list the main problems, or problem areas, with respect to water and water environments in Slovenia: wastewater, landfills, urbanisation, regulation of water courses, hydropower facilities, agriculture, non-native species, ecotourism and sport, as well as privatisation of water resources (National Geographic Slovenia 2021).

These problems affect the quality of water sources in Triglav National Park, widely considered the jewel of Slovenian nature, where the water in the water protection area is polluted, mainly due to agriculture; at the same time, the Triglav National Park staff lack the means to appropriately sanction the farmers (National Geographic Slovenia 2021). It is this discrepancy that led Girandon, Groleger and Pleskovič to focus their research efforts on the problems within Triglav National Park, the general belief in Slovenian society being that the nature there is pristine and unspoilt. (FIG. 21)

Since 2018, water from 13 springs in Triglav National Park has been undergoing regular sampling. Samples are taken 2–3 times a year, mainly during the summer months. The sampling results show that in the chemical sense, the situation is fairly stable, the exception being the presence of nitrates and phosphates, likely associated with agriculture. More problematic were the consistently elevated levels of E. coli detected in four of the springs—in some cases reaching more than 182 CFU/100 ml. (FIG. 22)

E. coli is a bacterium present in human and animal intestines whose presence indicates faecal pollution (WHO 2022). According to the Rules on Drinking Water (PisRS—Legal Information System), the limit value for E. coli is 0/100 mL, with anything higher indicating that the water source is to be considered contaminated. Higher levels of E. coli in humans and animals manifest as severe abdominal cramps, diarrhoea, vomiting and sometimes fever (Mayo Clinic).

Girandon, Groleger and Pleskovič analysed the existing solutions for purifying E. coli-contaminated water, including mechanical filtration, chlorination, UV-treatment, boiling and ozone treatment. In the analysis, they looked not only at efficiency and affordability, but also at sustainability.

In doing so, they found that artificial filtration technologies require regular maintenance and replacement of components, generating large amounts of waste. In addition, they usually require a lot of energy to operate, with the associated negative impact on the environment. They additionally found that chlorination, while effective, is not affordable for smaller towns and villages (Boutiller and Lee 2014). Boiling was also identified as an effective method for water disinfection, but the amount of fuel needed to disinfect water through boiling is several times more than what a typical family uses for cooking. Among the existing alternatives, UV disinfection has emerged as the most promising technology available. However, it also requires either electricity and maintenance if a UV lamp is used, or sufficient sunlight (Boutilier and Lee 2014).

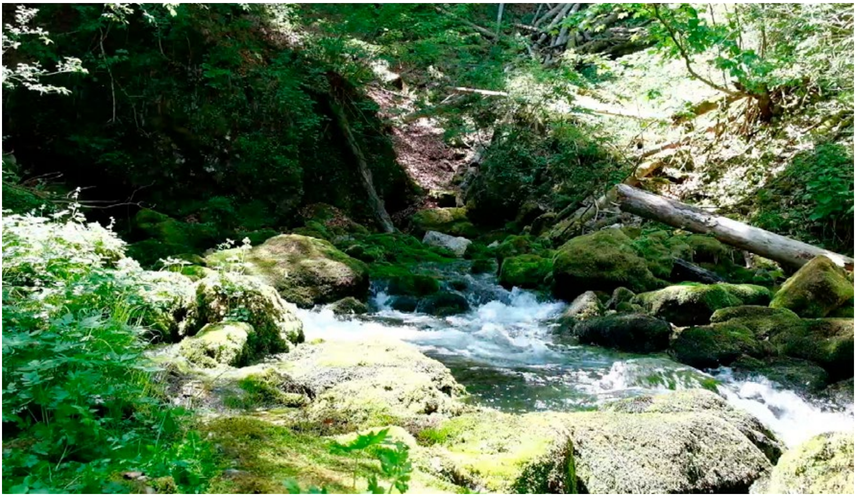
In the course of their research they also investigated vernacular approaches and found that in the past, water filtration was performed through methods that make use of natural processes and do not require a great deal of energy. The solutions were also adapted to local conditions and employed locally available materials (Islam and Rahman 2020, 119). Building on the natural options that were used in the past, before the invention and popularisation of artificial alternatives, was therefore crucial for the development of the project.

RESPONSE TO THE IDENTIFIED ISSUES

A vernacular approach to water purification enhanced by modern technology

The most common natural water purification techniques employ sand, oysters, plants, charcoal, coconuts, zeolite and limestone, bacteria and algae, xylem tissue, activated sludge, peels, irrigation fields and clay (Islam in Rahman 2020, 149–150). In the course of their research, the authors found that ceramic water filtration—a water purification method that uses filters made of clay—offers the most potential.

The use of ceramic water filters to remove contaminants from water dates back to ancient civilisations. Today, ceramic water filters are still in use in developing countries, as they are a cheap and effective method of water purification. The benefits of using ceramic water filters include their ability to remove numerous types of contaminants, such as bacteria and sediments. They are also simple to clean and maintain and have a long



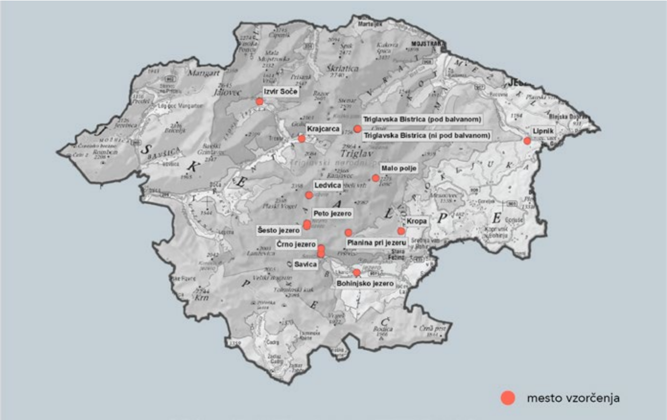


FIG. 21

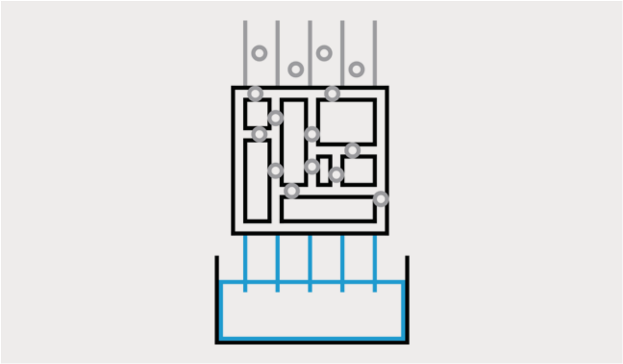
The Lipnik spring in Triglav National Park, 2022. Photo: Žan Girandon.
Izvir Lipnik v Triglavskem narodnem parku, 2022. Foto: Žan Girandon.

FIG. 22

Sampling sites in Triglav National Park, 2023. Photo: Žan Girandon.
Mesta vzorčenja v Triglavskem narodnem parku, 2023. Foto: Žan Girandon.

FIG. 23

Ceramic filtration, 2022. Photo: Bor Cvetko.
Keramična filtracija, 2022. Foto: Bor Cvetko.



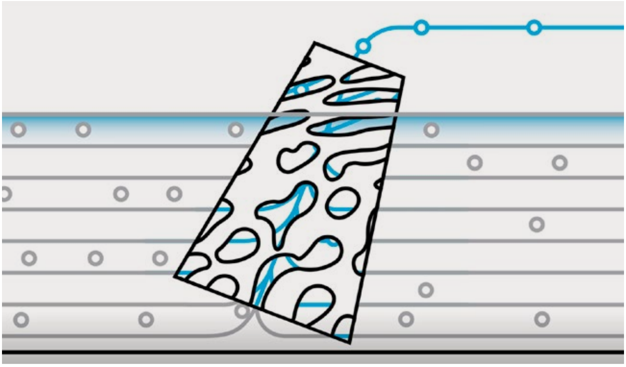


FIG. 24

Ceramic filtration is a mechanical type of filtration in which water is passed through millions of pores on the surface of the water filter. In this process, organic and inorganic particles too large to penetrate the porous material (anything larger than 0.5 micrometres) accumulate on the ceramic surface (Arvig 2014). Diagram design: Ema Kapelj, 2022.

Keramična filtracija je mehanska vrsta filtracije, ki deluje tako, da voda pronica skozi milijone por na površini vodnega filtra. Pri tem se na keramični površini kopičijo organski in anorganski delci, ki so preveliki, da bi pronicali skozi porozno snov (vse, kar je večje od 0,5 mikrometra) (Arvig 2014). Oblikovanje diagrama: Ema Kapelj, 2022.

FIG. 25

Operation of the Dodola filter, 2022. Diagram design: Ema Kapelj.
Delovanje filtra Dodola, 2022. Oblikovanje diagrama: Ema Kapelj.

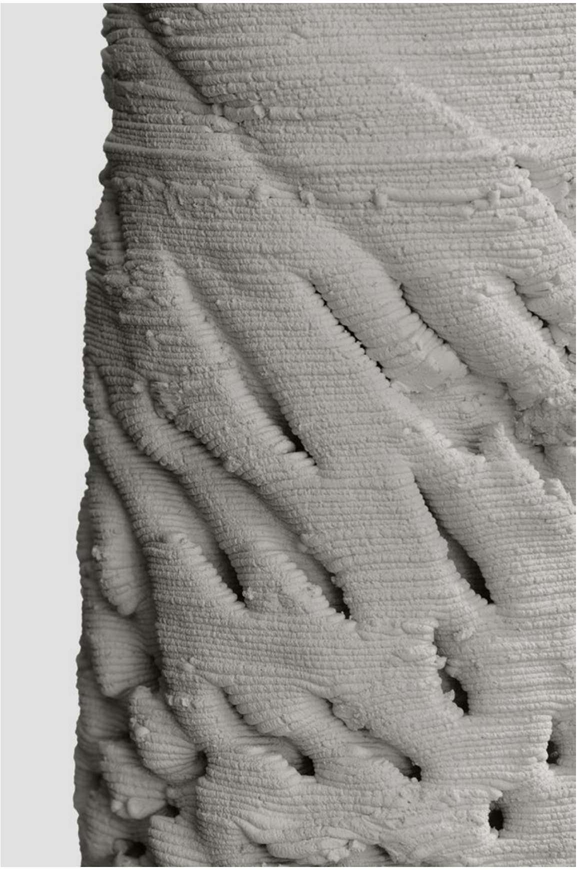


FIG. 26

Pjorkkala, Dodola (gyroid detail), 2022. A gyroid is an infinitely connected triply periodic minimal surface that was discovered in 1970 by Alan Schoen. The gyroid separates space into two oppositely congruent labyrinths of passages, which allow the formation of channels needed for the input-filtration component of the system (Schoen 1970, 1). Photo: Bor Cvetko.

Pjorkkala, Dodola (detajl giroida), 2022. Giroid je neskončno povezana trojno periodična minimalna površina, ki jo je leta 1970 odkril Alan Schoen. Giroid loči prostor na dva nasprotno skladna labirinta prehodov. Ta omogočata oblikovanje kanalov, ki so potrebni pri vhodno-filtracijski komponenti sistema (Schoen 1970, 1). Foto: Bor Cvetko.

FIG. 27

Pjorkkala, Dodola (detail of the Archimedes’ screw), 2022. An Archimedes’ screw consists of one or more helical surfaces wrapped around a central cylinder. Integrating a structure inspired by the Archimedes' screw in an object permits water to be transported upwards without user intervention and without electric propulsion (Wikipedia). Photo: Bor Cvetko.

Pjorkkala, Dodola (detajl Arhimedovega vijaka), 2022. Arhimedov vijak je sestavljen iz enega ali več spiralnih nizov rezil, ovitih okoli osrednjega valja. Integracija forme, inspirirane po Arhimedovem vijaku, lahko v objektu omogoči transport vode navzgor brez intervencije uporabnika in brez električnega pogona (Wikipedia). Foto: Bor Cvetko.

FIG. 28

Pjorkkala, Dodola, 2022. Photo: Bor Cvetko.
Pjorkkala, Dodola, 2022. Foto: Bor Cvetko.

lifespan. Needing no electricity or chemicals to operate, they are ideal for use in remote areas or areas that are not part of the water supply network. Their only downside is that they are not effective in removing chemicals and viruses from the water (Centers for Disease Control and Prevention). This was not a problem in the context of the thesis, however, as no chemical or viral contamination was detected in the waters of Triglav National Park. The authors further point out that ceramic water filters can be produced locally, reducing the need for transport and the associated carbon emissions. Further contributing to the sustainability aspect of ceramic products is the fact that they are fully recyclable at the end of their life cycle.

Ceramic filters are considered an extremely efficient method of filtration, as the porous structure removes up to 97.5% of bacteria, the exact value ranging from 80 to 97.5% depending on the amount of combustible materials present in the clay prior to firing. In addition to microbiological contaminants, ceramic filters also remove undissolved solids and larger particles in contaminated water (Zereffa and Bekalo 2017). FIG. 23–24

On a foundation of traditional knowledge, a product was created: Dodola,[1] which integrates vernacular knowledge enhanced through the use of modern technology. The result is a sustainable product for water filtration produced using 3D technology and employing principles such as the gyroid structure and the Archimedes' screw. The carefully designed filter modules remove bacterium-sized contaminants from the water, which is key to providing safe drinking water. In numerous tests, the module has demonstrated outstanding performance, resulting in an innovative design of a complex filter surface produced out of clay using 3D printing technology.

The Dodola is designed for use in natural environments, where the structure of the filtration system is positioned so that it reaches below the water surface. This allows water to pass through the porous material, which is how it gets filtered. The water flow induces a rotation that transports the filtered water towards the upper part of the module where it emerges as clean drinking water. Once the water leaves the structure, it flows along a trough to a point where it is accessible to users, or is piped to a drinking water storage tank. This allows easy access to drinking water for the local population and operation in remote locations where no electricity is available. FIG. 25–28

①
The project received the following awards: Distributed Design Award – Project Excellence, Zagreb Design Week – 1st Prize for Social Innovation, an award by Zavod BiG in the Perspektivni category and the the DOS Daljnogled award. It was also nominated for the Green Project Award.

The study highlights and actively addresses the problems of water source pollution and drinking water supply, issues that are crucial for a good quality of life, yet are quickly forgotten in a world where caring for our environment seems to always come last. In the search for a suitable solution to the investigated problem, the holistic approach of the team of authors was a decisive factor, as it ensured that the solution, in addition to being technically suitable, was also sustainable and regenerative and that it leads to a positive change in users' habits. The solution presented is tightly linked to vernacular and participatory design, as it puts at its centre the communities that are facing daily issue due to the lack of adequate infrastructure for water purification. The proposed solution overcomes the negative impacts of scarcity by empowering on two levels, offering a sustainable product that serves both as a device for water purification and a medium for revealing a problem that is often invisible and unknown. Finally, the resulting solution is not only important for the empowerment of local communities, but also clearly demonstrates the need to re-establish a common relationship with water, which is too often neglected and taken for granted, despite our inescapable dependence on it.

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