water mining
value for society

Deliverable 1.4

Ethical Report

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Author(s)	Gijs Arnold (TU DELFT) Lotte Asveld (TU DELFT)
Contact	l.asveld@tudelft.nl
Reviewers	Patricia Osseweijer, Louis Lemkow
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1. Introduction

Water is undoubtedly one of the most important ingredients to human survival and wellbeing. Besides needing drinking water for our survival, we rely on water for our hygiene and sanitation, for food and transport and for leisure and pleasure. The United Nations (UN) recognises “access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use” as a basic human right, with sufficient being quantified by the World Health Organisation (WHO) as 50-100L per person per day [1]. Presently, 2 billion people live in countries experiencing high water stress [2] and water demand is projected to exceed supply by 40% in 2030 under the business-as-usual climate scenario [3]. The “water crisis” finds its spot in the top five societal risks of the World Economic Forum since 2011 and is connected to a range of sectors including society, climate, energy and economy. At the root of the water crisis are population growth, an increase in water demand due to rising living standards and unsustainable water management practices. The changing climate aggravates this crisis which disrupts the global water cycle and causes precipitation to become unpredictable.

To ensure sufficient water supply and quality for the next generation, these risks will have to be addressed now. The WATER-MINING project of the EU is trying to do just that. The aim of this project is to assess and advance the state of different technologies dealing with waste water treatment and reuse. It does this by building, operating and optimising pilot scale facilities and by partnering with stakeholders in the fields of urban- and industrial waste water treatment and desalination facilities. As such it contributes to the UN Agenda 2030 and its sustainable development goals (SDGs). Goals of Agenda 2030 related to this project are Goal 6 “Clean Water and Sanitation” and Goal 13 “Climate Action”. The Goal 6 objective is to “ensure availability and sustainable management of water and sanitation for all” while Goal 13 urges us to “Take urgent action to combat climate change and its impacts”. In this context Goals 1 (No Poverty), 3 (Good Health and Well-being), 7 (Affordable and Clean Energy), 14 (Life Below Water) and 15 (Life on Land) are also relevant. Agenda 2030 and its SDGs are being used as a roadmap by many European governments and the European Commission in terms of action on the future social and environmental well-being of citizens and society and Water Mining aims to contribute to the solutions.

The project consists of six case studies where a pilot scale is developed, all dealing with waste water from differing sources, and eleven work packages that deal with the technicalities of the systems as well as with stakeholder commitments, evaluations, building communities of practice and communication strategies. Both the case studies and work packages will be discussed in further detail in this report.

This project, without a doubt, strives to develop technologies that progress and benefit our societies. However, even technologies developed with the best of intentions can have unforeseen consequences and could pose ethical dilemmas, if these are not accounted for in the design phase. The WATER-MINING project takes care to examine both the case studies (CS) and work packages (WP) for any ethical issue that might come up and will lay out a plan to address these in this report. The design implications for the pilot plants will be addressed in the Value Sensitive Design (VSD) which is also part of the project as a whole.

This ethics report is part of WP1 and falls under the responsibility of the project management team (PMT). The PMT oversees and coordinates the WATER-MINING project as a whole and will be responsible for the implementation of the findings in this report by the other WPs. This report serves as a first inventory of possibly ethical issues. This issues will be further investigated in collaboration with the consortium members. Issues that we identified now, might turn out to be not so relevant, while others may be added.

The ethical issues that were foreseen for now are discussed below. The report starts with general issues such as data management and inclusion. The remainder of the report focusses on more specific issues related to specific case-studies or work packages. These will be illustrated by examples from the CS. Where relevant, possible solution to the issue will be proposed.

2. Ethical Issues

The first two issues are general for the whole project, the other issues related to specific work packages.

2.1. Inclusion and Diversity

The PMT are responsible to monitor for and act against any form of discrimination on any basis in any of the WPs. A good start by the PMT is the gender diversity in the leaders of the WPs, with 50% being female and 50% male. This responsibility extends to the partnering companies. Although the PMT may not directly choose the representatives of these companies, they can be observing and can address the partner on any discriminating actions that might be found. Any action undertaken by a member of the WATER-MINING consortium should not violate the UN declaration of human rights.

Social diversity should not only be regarded as a normative value, but also as an instrumental one. A diverse team can provide broader input to a project and come up with a wider range of ideas, potentially achieving in a result that satisfies more values. Diverse work package teams within the WATER-MINING project should therefore be regarded as a valuable asset.

The communities around the pilot plants should not be negatively affected by its operation. Ways a plant could adversely affect the people living in that area might be by noise pollution, smell or by negatively affecting the aesthetic value of an area (e.g., when a plant would be built in a natural landscape). This wellbeing, or social sustainability, of the communities around the plant has to be taken into account in the design process. The people living in the communities around a pilot plant usually do not participate in the engineering of the plant, but they will be affected by the result, making them stakeholders. These people should be given the chance to provide input in the process by sharing the values that they think should be upheld. These can include ‘living in a quiet neighbourhood’ or ‘fresh air.’ For the design this would mean a maximum decibel level and maybe an off-gas filter.
The identification of the communities’ values is the task of WP team 2 that is responsible for the VSD. When gathering information about the values of the communities, this team should target a diverse group of correspondents to provide input.

2.2. FAIR use of DATA

Personal data of citizens and stakeholders will be collected, especially in WP2, 7 and 11, requiring data governance protocols. These are covered with the data management plan D1.2 for the consortium. Any participant in the interviews or surveys should be provided with the information in Article 13 of the “REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT

AND OF THE COUNCIL on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)" [4]. The amount of data to be collected will be limited and since data processing is not at the core of this project, a data protection officer will not have to be assigned. Data gathered and conclusions drawn should be made available to the public, either open source or by easy licensing. This way, the impact of the pilot plants will be maximised.

2.3. Ownership and Just Distribution

For every case study, ownership of the technology and a just distribution of the derived benefits are key values. The WATER-MINING project is a collaboration between universities and companies and is funded by the EU. This raises the question: who will be the beneficiary of this project? If patents are awarded for the work, who will hold these? Although the companies collaborating with the project are essential for its success, they should not be the sole beneficiaries. With citizens of the EU indirectly funding the research, some of the benefits should be awarded to them as well. This can be achieved by drawing up contracts beforehand that state that: if a company commercialises the technologies developed in this project, part of the revenue will have to go towards the community surrounding the plant. For brine treatment of desalination plants, this can be achieved through lower costs for water and electricity. For the treatment of WWTP effluent, this can be through lower sewage levies or taxes.

Besides the issue of funding, there is the issue of ownership over the waste stream that is being treated. Especially for CS treating urban wastewater. This wastewater can be regarded as a common good. A company that stands to make a profit from this common good will have to distribute some of this profit over the owners. In the Water-Mining Grant Agreement en Consortium Agreement arrangements have been made for the distribution of benefits and ownership resulting from innovations made within the consortium.

Example from CS 1

The pilot scale at Lampedusa will treat the brine of the desalination unit that provides water for the island's power station. This process has the potential to valorise the brine, adding a source of revenue for the operators of this power plant. Part of this revenue should go to the inhabitants of the island, for example by lowering their electricity bills.

If the technology will be used to treat brine from desalination plants that provide drinking water, the price of water can be decreased.

Example from CS 3, 4 & 5

In a certain way, extracting materials from wastewater is making money off of the common good. People pay for their wastewater treatment in the form of levies or taxes. These levies or taxes exist to operate the WWTP for the benefit of all. They are used to cover the costs for treatment. These costs include the costs of disposal of the wastewater sludge (transport, agricultural use, incineration etc.). If, instead of disposing the sludge, it is used as a (valuable) resource, some of the profits should be reflected on the taxpayer (who is also the 'original producer' of the sewage). Demanding levies grants a form of ownership of the result. Collectively, we want our (surface)waters to stay healthy, so we pay for the process of cleaning up our wastewaters. If, instead of incinerating the sludge, it is being used to profit from, this ownership should not be impaired and the benefits should be distributed fairly.

Of course, there should still be an incentive for companies to invest in the implementation of the technology and to operate the facilities. This will also benefit the public by decreasing wastes to the environment and providing job opportunities and tax revenue. However, if the process stands to make substantial profit, the taxpayer should be given a piece of the sludge-pie.

This distribution can be safeguarded beforehand by agreeing on a reduction of levies/taxes for the citizens, paid for with the profits from the new process, if such profits are realised.

2.4. Infrastructure Dependencies

Many of the technologies developed in the WATER-MINING project aim to realise sustainable and durable solutions to access to clean drinking water. However, since the water- and energy infrastructure is already well established in many of the areas of the world where WATER-MINING operates, the pilots will have to be developed within this existing infrastructure.

Improving the existing infrastructure can lead to short-term benefits (value of effectiveness), but simultaneously cements this infrastructure. This cementing may slow down larger changes/paradigm-shifts to/in the infrastructure that would potentially have been be more beneficial in the long-term (value of sustainability). This situation may cause frictions that need to be addressed in the set-up of the pilot plants.

Another unintended side-effect that the wastewater valorisation options proposed in the WATER-MINING may have, is that they will create a business model around waste. The companies that generate revenue from this waste by operating the technologies of this project will not be incentivised to stimulate people to lower their wastewater production, since this would cut into their own revenue. This is another way the short-term benefits clash with the long-term goals.

Researchers within WATER-MINING will have to be aware of possible dependencies on existing local, unsustainable infrastructures, and also on the social economic embeddedness of this infrastructure. When setting up the pilots, alternative to the current infrastructures will have to be considered. Can the pilot easily switch between energy sources, for instance? Is the technology scalable? Within WP2, the approach of value sensitive design is applied to the overall project. This approach help researchers to become aware of value tensions for design and find ways to effectively deal with this.

Example from CS1

The environmental benefits of decreasing or eliminating altogether the brine disposal in the coastal seas are significant. However, the CS mentions that waste heat will be used in order to operate the treatment facility. This raises questions and potential issues. For starters, where does this heat originate from? Logical option: the 22MW power station runs on diesel engines supplying 100% of the energy of the island. In the short run, using the waste heat from this installation is a great option, reducing the impact of the facility. In the long run, however, the reliance on the heat generated by burning diesel oil will cement the dependency on this (archaic) system of electricity generation, possibly slowing or halting the transition towards renewable forms of energy generation. The increase in inertia of the diesel power plant can potentially not only harm the environment, but also the local population by increasing electricity costs and air pollution.

The option to switch to renewable energy generation should be discussed beforehand. For the pilot plant, this would require an alternative form of heat generation from renewable sources.

Example from CS 3, 4 &5

Large scale WWTP are the norm in cities and will likely continue to be in the future. Valorising the treatment process while decreasing the environmental impact will be a positive development. However, building on to the existing infrastructure does increase its inertia. The large WWTP we see today in our cities come with a lot of benefits, but also require large amounts of energy to operate and to pump the wastewater from our homes to the plant location. Smaller scale, community treatment and recycling or mixed wastewater collection might very well proof to be more efficient in certain neighbourhoods, but since the infrastructure and knowledge for the existing plants is already in place, these smaller scale initiatives might not draw the necessary attention and funds to reach commercial scale [6]. Adding onto the existing infrastructure will only decrease the incentive to develop new technologies or management techniques. Although lowering the impacts of our current practices is great, it is focussed on the symptom (wastewater) and not on the problem (excess wastewater production). Alternatives such as separate black, yellow and grey wastewater collection and recycling might be better in the long run, but will likely see their implementation delayed by cementing the status-quo. The WP teams can overcome this potential issue by designing their system to be scalable. This will improve robustness. If there is a move towards smaller scale WWTP, the technology can be easily integrated in these systems as well.

CS4 illustrates this in another manner. Already, 100% of the wastewater from the WWTP in Cyprus is reused. The problem that the CS sets out to solve is the high level of salinity of this water, which is a threat to soil health when reused. If, however, the salt can be prevented from entering the wastewater in the first place, the whole system that will be designed will no longer be required. This would save time, money, labour and energy in designing, building and operating the system.

2.5. Safety

2.5.1. Plant operation safety

All pilot plants should be designed to ensure utmost safety for its operators and immediate surroundings. Hazardous chemicals should not be used in excess and only be handled by trained and certified operators. Machinery with exposed moving parts, high outside temperature, under high pressure or with otherwise hazardous features should be clearly marked as hazardous and ideally should be demarcated. Such machinery should also only be operated by trained, qualified staff.

The operations of the wastewater treatment facilities should not jeopardise upstream operations. There should be no risk for the upstream facility that they cannot discharge their effluent. General local safety standards in place at specific facilities will need to be respected by all those working there as well as by those actors who are developing new practices.

Example from CS1 & 2

A failure in the brine treatment facility might disrupt the effluent from the desalination plant, causing operational issues upstream. To avoid this potential complication, redundant discharge pipes can be installed at the desalination plant, or just upstream of the brine treatment facility.

Example from CS3 & 6

The extraction of Kaumera requires strong acids and bases for the large pH shifts and/or the use of solvents. These chemicals should only be handled by qualified staff and only in the minimal required amounts. To improve workplace safety, operators handling hazardous chemicals or machines should be re-trained regularly. Additionally, audits on workplace safety may be conducted to identify any bad practices or unsafe situations.

Examples from CS6

The switch from grade 7 to grade 2 titanium in the large-scale pilot plant is a positive development. Grade 7 titanium contains palladium, a rare metal and valuable metal, whereas grade 2 does not. The flipside, however, is that grade 2 titanium is less corrosion resistant than its grade 7 cousin. With the brine containing organic compounds, possibly reducing acids, the durability and corrosion levels of the new material should be closely monitored. Since the new material is applied in a relatively large demonstration plant of 2-3 m^3/h, high corrosion levels could be a concern for worker safety as well as for the immediate surrounding environment, should a leak occur. KVT will lead the start-up of the system for approximately 1 month. However, this might not be enough to fully assess the durability of the new material. Titanium levels in the effluent of the plant should be monitored. If titanium is found in the effluent, this can be a sign of elevated corrosion. Additionally, periodic physical inspection of the lining of the HPO unit (where the new material is being used) should be conducted. This would require periodic shut down of the plant and possibly partial dismantling to inspect the lining.

2.5.2. Environmental safety

Environmental impacts are high on the agenda within WATER-MINING and will generally be addressed by WP8. Researchers should be aware of possible negative impacts on the environment and take measures to decreases uncertainties and deal with known risks. The fact that the pilot plants will treat existing wastewater means that the effluent of the plant will, if all goes well, have lower concentrations of the pollutants than in the influent. However, new pollutants might enter the stream during the treatment process, either deliberately (acids/bases, solvents) or by leaching from the materials of the machinery. Such potential pollutants should be monitored in the effluent

Energy efficiency of all processes should be assessed against their obtained benefits. Is it acceptable to use X amount of energy, money and labour to remove Y amount of pollutant, or could these resources be put to use more efficiently somewhere else? Finally, the impact on and proliferation in the environment of the recovered minerals and materials should be assessed for all cases. These recovered products may contain heavy metals or active pharmaceutical ingredients (API) that were concentrated in the treatment process [7]. Both pollutants should not enter the environment. It is projected that the effects of APIs in wastewater will cause more deaths than cancer by 2050 [8]. The levels of these pollutants should be quantified and the results should be shared with WP 8 and 9 so they can properly assess circularity and applicability. If the pollutants exceed legal limits or other norms for safety, design strategies should be developed to deal with this.

Examples from CS3

A proposed use of Kaumera is as an additive to improve stiffness, heat resistance and non-flammability of the composite and as a binding agent. The use of additives in materials can drastically change their recyclability and/or degradability. Cardboard is easily recycled, but a Kaumera-cardboard composite might not be. Especially when considering the use of an additive in single use products such as packaging, the impact on recyclability and degradability should be quantified.

The extraction process includes large pH shifts and a prolonged elevation of the temperature to 80 degrees C which kills all pathogens. This eliminates the concern of spreading pathogens with Kaumera. This extraction process does, however, raise environmental concerns. Large quantities of chemicals will be needed for the pH shifts and a lot of energy to heat the water to 80 degrees Celsius.

The environmental impacts of extracting and using Kaumera are not yet adequately assessed. Wageningen published a paper with an LCA, but the impact of Kaumera ranged from a positive 115kPt to negative 11kPt (kPt used in LCA as a generalised score, taking various factors into account) [7]. They mention that further research on the true environmental impact of Kaumera extraction is needed to confidently determine an LCA score.

Examples from CS4 & 5

Salts and phosphorus are recovered from the wastewater to refine the water to such an extent that it can be recycled. This has great environmental implications. However, in order to extract those salts from the aqueous phase, reverse osmosis, nanofiltration, evaporation, distillation and crystallisation operations are required. These operations require (lots) of energy. In a world where most energy is still being produced unsustainably, the added benefits of each energy consuming operation should be considered. Heat integration within the process and the use of waste heat from other sources should be considered for these operations. Additionally, there is no mention of water recycling in some of the CS (e.g. CS3). Combining technologies of different CS to recover this water may be beneficial.

Example CS1, 2 and 6
Besides internal use of recovered salts, these salts may see use in the de-icing of roads. The salts recovered should be analysed to ensure that environmental safety standards are met. If the salts would contain environmental pollutants (e.g. heavy metals), these could find their way from the roads to the surrounding fields and build-up and persist in the environment.

2.6. Governance and Legislation

Counter-effective governance or legislation can block even the best designed and well-intentioned projects. Extreme cases are corruption, nepotism and authoritarian governments with miles of red tape. More nuanced are pieces of legislation that are contradictory or have unintended/unforeseen consequences with regards to a project that had not been foreseen at the time, or inexperienced management. WP 10 studies existing policies and sets out to develop a policy package for WATER-MINING and the circular economy. It is advised that the team working on this WP also examines the laws and agreements in place at the sites of the pilot plants.
The team of WP 10 is advised to look deeper into the legislation and contracts for each CS separately, to prevent potential problems that could arise when the WATER-MINING project is successful and is scaled up to commercial scale. The existing legislation should be examined and new legislation can be drawn up for each CS to ensure that the implementation of the developed technologies adheres to each value mentioned in this report or otherwise identified. The policy packages should contain mechanisms to prevent intended (corruption, nepotism, etc.) and unintended (ineffective or contradictory legislation) forms of mismanagement. Awareness about these issues within WP10 can be achieved through questionnaires and follow-up discussions with relevant participants.

Example CS1
This example does not concern the pilot plant, since it will be used to treat the brine from the desalination plant of the power station. It concerns commercial scale application on the island when the technology is used to treat the effluent of the desalination plant that provides the drinking water for the inhabitants of Lampedusa.
The water department of Sicily is obliged to buy all desalinated water from the operator of the desalination plant. If the water that will be recovered by the brine treatment facility is of sufficient quality for reuse, this would double the efficiency of water desalination (assuming

an efficiency of 50% for the desalination plant). In turn, this implies that the desalination plant would only have to operate at 50% of its current capacity to cover the island's water needs. However, if the current contracts with the government are upheld, the desalination plant would have no incentive to lower its capacity, since the government is obliged to buy their water at a fixed price. This could lead to a substantial overproduction of water on the island.

2.7. Appropriate Technology Transfer

For the CS were the technology will be implemented in different countries, i.e. CS 3 and 6, it is important to ensure a good technology transfer. This can be achieved by ensuring sufficiently elaborate and detailed operational and troubleshooting manuals. The engineers of the system should be able to explain to a third party with no experience in operating the system, how to safely and effectively operate and troubleshoot their system. Additionally, the level of English of the operators in all CS countries will have to be assessed to make sure that the knowledge needed to operate the system is adequately transferred. If the level of English is deemed insufficient for proper comprehension of the manuals, the manuals shall be translated to the language native to the operators. A potential obstacle to appropriate technology transfer is cultural differences in working ethics. To a work floor supervisor in country A, carrying out certain task may be assumed 'obvious' and instructing the operators for this might be seen as patronising, whereas in country B, this task might not be something that comes naturally to the operators. It should be very clear what exactly is expected from the operators, even if this might be redundant information to some, it may prevent failures in the system in the future.

Apart from the correct transfer of the operational instructions, the technologies will be transferred into different realities. Country A might face completely different problems and hold different values than country B. The difference in problems can be that the wastewater in country A is of a different composition than that in country B. A difference in values can be that country A values water efficiency but energy efficiency not so much, whereas country B might opt for the most energy efficient process whilst not caring too much about the water efficiency. In the WATER-MING project, this variability is addressed somewhat for CS 3, where the pilot plant will be tested in both Portugal and the Netherlands to check for the variability in temperature. These comparisons might also be required for other factors such as the composition of the wastewater. A sensitivity analysis of the design could already cover some variability. Through the Grant Agreement and the Consortium Agreement some arrangements are in place to deal with fair and effective technology transfer. To the extent that they still need to be developed, this will be done through activities in WP2 Value Sensitive Design and through questionnaires and discussions with relevant participants.

2.8. Automation and Responsibility

WP 7 will develop a control and optimisation dashboard “supporting an end-to-end process of data collection, harmonization, processing and visualization for evidence-based decision making.” If this control panel will be used by the plant operators to monitor the plants operation and if the panel will make certain decisions autonomously, the responsibility for any failures in the plant’s operation will be blurred. Automation is generally a good development, decreasing the responsibilities of the human operators. However, there might still be a need for human interference from time to time and in some cases, emergency adjustments might be required by the operator. For the operators to be able to perform their role adequately, they must know what responsibilities they have within the socio-technological system and they must also know what the responsibilities are of the computer system monitoring the plant. If it is unclear what they role of the computer is in the system, the operator might attempt to undo actions taken by the computer, or perform actions that impair the correct functioning of the system. An example is given in the Handbook of Ethics in the chapter ‘Design for Values and Operator Roles in Sociotechnical Systems’ by M. Franssen on pages 124-125 [9]. In this example, two aircrafts were on collision course with each other. They both had airborne collision avoidance systems (ACAS) on board that would automatically detect such scenarios and send instructions to the pilots of both aircrafts; to one they would send the instruction to climb in altitude, to the other to descend. In this case, however, the air traffic controller on the ground noticed the collision course of the planes late and instructed one of the pilots to descend, unknowing that the ACAS had instructed this same pilot to ascend just seconds ago. This interference of a human operator caused the collision of both aircrafts that were now both descending and again on collision course. Had the air traffic controller realised the role of the ACAS and had the pilot been instructed to follow the ACAS instruction above any and all other instructions, these planes would have not collided and 71 lives would have been spared.

The sociotechnical systems (the pilot plants) in this project obviously do not pose such a potential danger to human life, but this example does illustrate that a system in which both human as machine operators work simultaneously can cause conflicts and potentially system failures.

To combat this, the engineers of the computer systems should provide clear instructions to any human operator with the distribution of responsibilities. There should be a high level of transparency for any automated system.

If there are human operators involved in monitoring and controlling the plant, it is important to ‘engineer’ their tasks as well, or at least to engineer the system with the human operator in mind. Humans are not machine components and cannot be expected to mechanically perform tasks that are instructed to them (through the computer system). They are conscious beings, making conscious decisions every time they decide to act. Their ability to perform their tasks adequately is dependent on many variables. As many of these as possible should be determined at the design phase of the plant. One factor of particular importance but simultaneously difficult to design for is that work must be worthwhile and rewarding for the person doing the work. From the Handbook of Ethics page 130-131: “To secure adequate role performance, execution must be made worthwhile and rewarding, but whether it actually is depends on circumstances which lie to a large extent beyond the scope of system designers and are difficult to foresee.” Awareness about this issue in WP7 can be checked by questionnaires and if needed stimulated through discussions with relevant participants.

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