INADE

Open Education for Adults in the field of Industrial Water Management

MEF for adult education in the field of wastewater management

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Content

Executive Summary

This document presents a Modern Education Framework (MEF) for adult education in the field of wastewater management. Following the introduction, Chapter 2 identifies and assesses the requirements that such a framework must fulfil. In doing so, the perspectives of the various stakeholders concerned are also addressed in order to identify proper synergies.
Subsequently, an action guide is presented under Chapter 3, which will help develop an action plan needed to tackle current problems and to tailor the training or education programs based on competence levels in water education. The process is based on analysing the framework and the connected obstacles.
Chapter 4 deals with Formal, non-, and informal training and education in the (industrial) water sector, referring to the European Qualifications Framework (EQF), training available in Germany. The chapter addresses also non- and informal education in the water sector, academic training paths, and concepts for post-graduate training of academic and equivalent staff using the example of the Master of Advanced Studies (MAS) in Switzerland.
Chapter 5 focuses on sustainability aspects of education in the water sector, respectively how the 3 parts of the sustainability triangle, economy, ecology and social issues, can be incorporated and expanded in education. Furthermore, the use of digital tools in the water sector is analysed with a view to supporting teaching, also in the field of decentralised learning. Another topic is the financing of training; a possible solution is presented using the Qualification Opportunities Act in Germany as an example.
Chapter 6 briefly presents the case study of the North Italian industrial water sector and how the MEF approach chosen here can also be transferred. For a more detailed analysis of this sector, please refer to **"Analysis of trends and perspectives of adult education in the field of wastewater management in Germany and Italy"** which is also part of the INADE project.
Finally, Chapter 7 provides general recommendations for a modern educational framework for industrial water treatment and management in Europe that can be developed based on best practices.

1 Introduction

The water sector, like many other sectors in Europe and around the world, faces multiple challenges in the current and future labour market. Due to demographic change, which particularly affects western nations, the already existing shortage of skilled workers is being further fuelled. With the retirement of the baby boomers (people born between 1946 and 1964) from the labour market, a lot of knowledge will be lost in the next few years, in addition to the loss of workforce, if no action is taken. On the other hand, the water sector is constantly changing due to the increasing impact of digitalisation, the legal framework update and technological progress.
Irrespective of the shortage of skilled labour, the advancing climate change poses new challenges for the water industry, especially in arid regions. Providing drinking water, expanding wastewater treatment infrastructure to enable water reuse, and flood protection are just some of the issues that will become increasingly important in future. Education has a fundamental role to counteract this processes, and can furthermore encourage changes in behaviour to promote a more sustainable society, in terms of economic viability, social equity and environmental protection (UNESCO, 2009).
In this context, the elaboration of the present modern education framework is meant to contribute to providing recommendations for adequate education and funding programmes by identifying emerging problems and presenting solutions, combining best practices from different approaches, while identifying and building on synergies between different approaches.

2 Objectives of the Modern Education Framework

The MEF acknowledges that the stakeholders involved have different requirements and needs regarding their individual perspectives. In this case the three main stakeholders are: **a.** the industry/employers, **b.** the employees and **c.** the government. Ideally, the frameworks bring together their different requirements and needs as much as possible and maximize the resulting synergies. Topics that should be covered in such an adult education program in industrial water treatment and management should focus on training for new technologies and best practices including the following:

- **Water treatment processes**: This includes the physical, chemical, and biological processes used to treat water for industrial use, such as coagulation, sedimentation, filtration, disinfection etc.
- **Wastewater management**: This covers the collection, treatment, and disposal of wastewater generated by industrial processes. It includes topics such as wastewater treatment technologies, wastewater reuse and recycling, and environmental regulations related to wastewater discharge.

- **Industrial water pollution control**: This focuses on the prevention and control of pollution caused by industrial water use. It includes topics such as pollution prevention strategies, monitoring and testing of water quality, and compliance with environmental regulations.
- **Environmental legislation**: This covers the legal framework governing the use and management of water resources in industrial settings. It includes topics such as water rights, environmental permits, and compliance with environmental regulations.
- **Digitalisation**: Use of digital tools such as augmented reality operation, digital water management, predictive maintenance, predictive analytics or digital topographic

2.1 From the industry/employer's perspective

The industry is facing several problems when it comes to providing a sufficient and demand-oriented trained workforce. The demographic changes in western cultures lead to an aging population and thus to a decline in workforce and a potential loss of knowledge if the transition processes fail. The implementation of standardized education, especially for the blue-collar-jobs, is crucial for employers. Most workers in the water sector are lateral entrants without direct training in the field of (waste-) water related topics, resulting in a very heterogenous workforce in terms of knowledge and practical skills. These educational standards need to be based on the technical standards that apply in the country, so an overarching approach for all regions and/or countries should not be targeted within the MEF. Another aspect that needs consideration is the strengthening of cooperations between the industry and educational institutions on all levels to recruit young people as early as possible to enable need-based training. Regarding the regulatory compliance employers are also in need for legal certainty which is based on a uniform legislation.

2.2 From the worker/employee's perspective

The requirement profile in the water sector is characterized of high demands and versatility. Unfortunately, this fact is not reflected in the salary structure or the social recognition, which may be a threshold for new workforce to join the water sector. The demographic change will have a positive impact on the salary structure in general. Less workforce with simultaneous consistent or rising demand of it, should result in higher salaries. Creating awareness of the importance of high-water quality and the professions associated with it will also increase social recognition in society and consequently the salary structure.
Since there is a lack of standardized education programs in many countries, a lot of employees join this sector laterally without gaining any official certificates for their new

position. This leads to a high degree of dependence on the respective employer. To counteract this, independent, accredited training opportunities must be created that open career development opportunities for workers. To ensure this, education and training offers for professional development must be implemented and supported by publicly recognized organizations.

2.3 From the government's perspective

Water related questions will increasingly come to the fore in the future on the political level. Changing precipitation patterns in particular will bring new and greater challenges. In the wettest parts of Europe, precipitation is generally increasing, while the regions with less precipitation are becoming even more drier. At the same time, the frequency and intensity of climate-related extreme weather such as heat waves, heavy rainfall and droughts are occurring more often. To face the situation, qualified workforce needs to be ready for climate change related issues like droughts or floods etc.

Many countries, including Germany and Italy are struggling also with demographic changes. The aging of the population poses many problems for the government. The aging workforce impacts on national productivity, economic growth, and global competitiveness; it is important to attract workforce, especially young people to also reduce youth unemployment and, on the other attract foreign workers. This can be achieved by strengthening working conditions, salary, social acceptance, and social recognition.

Another main issue is the inefficient cooperation between different involved ministries in many countries and the resulting competence wrangling. More attention needs to be paid to this problem by improving and expanding cooperation at government level, (ministries responsible for the environment, economy, education, etc.) in order to make the best use of synergies.

Boundary conditions for standardized education must also be established on the government level, based on the European Qualifications Framework (EQF) and build on technical standards that apply in the country and the EQF. To maximize synergies in the field of water supply and wastewater treatment and disposal, these work fields need unification.

3 Analysis of the framework conditions, problem analysis and action planning

In order to develop a MEF for the water sector, the prevailing framework conditions must first be determined. This includes, among other things, an evaluation of the conditions at the national level, such as the demographic situation, the situation on the

labour market, and the economic status of the region or country in question. Another important point is an evaluation of the respective legislation. After the data have been collected and the framework conditions have been defined, the *problem analysis* follows. Here we look at the water sector in detail. How great is the need for workforce, also in relation to the different competence levels, and which companies are active in the water sector in order to be able to identify possible discussion partners. The *problem analysis* should include companies and people who work in the sector. At the same time, an attempt must be made to extrapolate the information in order to be able to identify shortcomings at an early stage. In the context of INADE, this was carried out with the **"Analysis of trends and perspectives of adult education in the field of wastewater management in Germany and Italy"**.

After conducting the basic data acquisition and the subsequent problem analysis, the development of an action plan is the next step, needed to tackle current problems and to tailor the training or education programs based on competence levels in water education. A schematic workflow of the order and possible survey parameters is depicted in Figure 1.

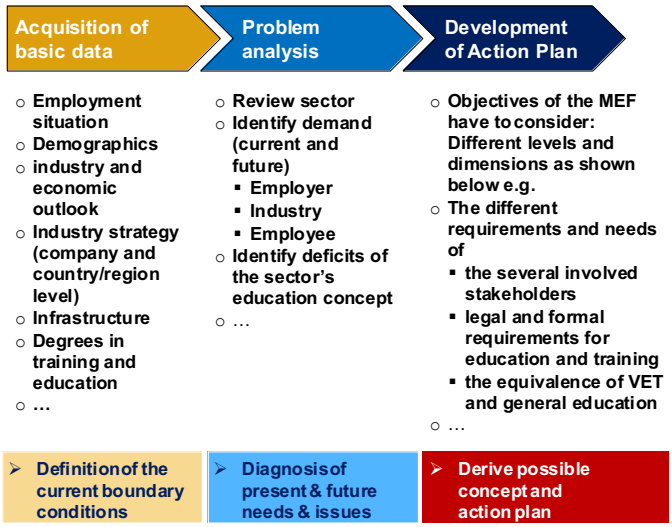

Figure 1: Workflow in action planning for the Modern Education Framework

4 Formal, non- and informal training and education in the (industrial) water sector

4.1 Professional education and vocational training

Although the education systems in the European Union (EU) have many overlaps, each country has its own education system, which leads to difficulties in assessing cross-border qualifications in a European context. To ensure the comparability of the different National Qualification Frameworks (NQF) within the EU, the EQF was invented. It covers all kinds and levels of education. The competence raises with the level which is ranging from 1 to 8 where 1 is the lowest and 8 the highest. Figure 2 depicts the different EQF levels linked to the general educational qualification. It also shows that the academic level starts at EQF level 6.

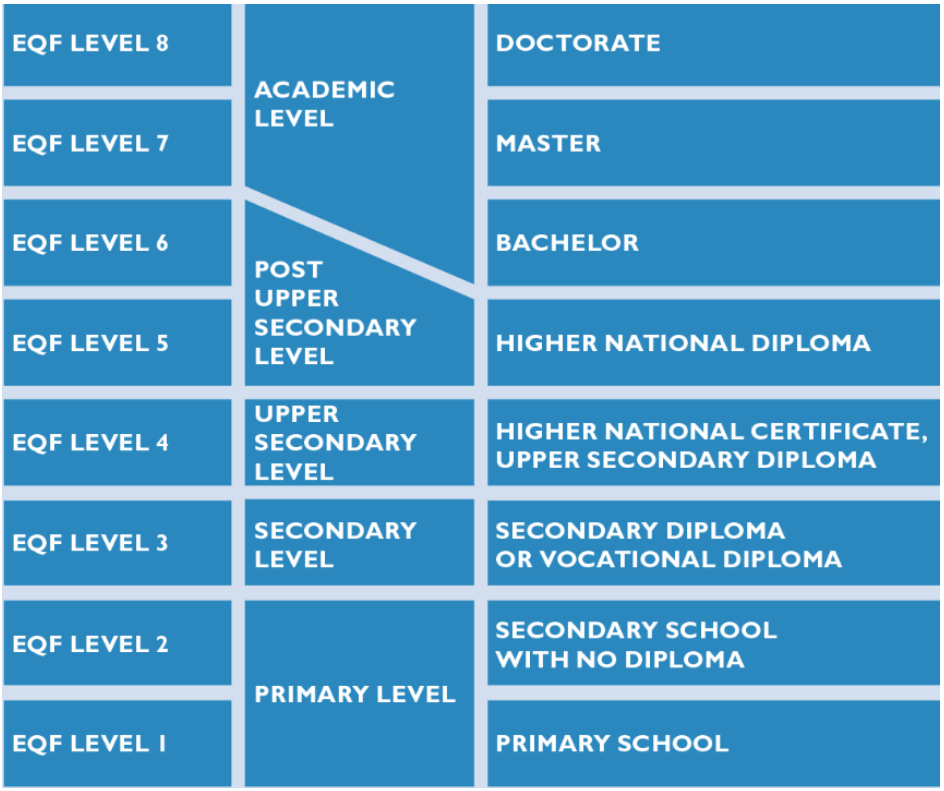

Figure 2: EQF levels linked to the general education qualifications (Hladík *et al.*, 2012)

The alignment of the NQF to the EQF is the responsibility of each country. For the assignment of the NQF to the EQF, each country must prepare a detailed assignment report based on the ten EQF mapping criteria, which is reviewed and approved by the EQF Advisory Group. Reviewing and updating the chosen assignment is an ongoing process for each country. The interlocking and grouping of the national qualification

frameworks with the EQF are depicted in Figure 3, where the national qualification levels are assigned to the EQF level.

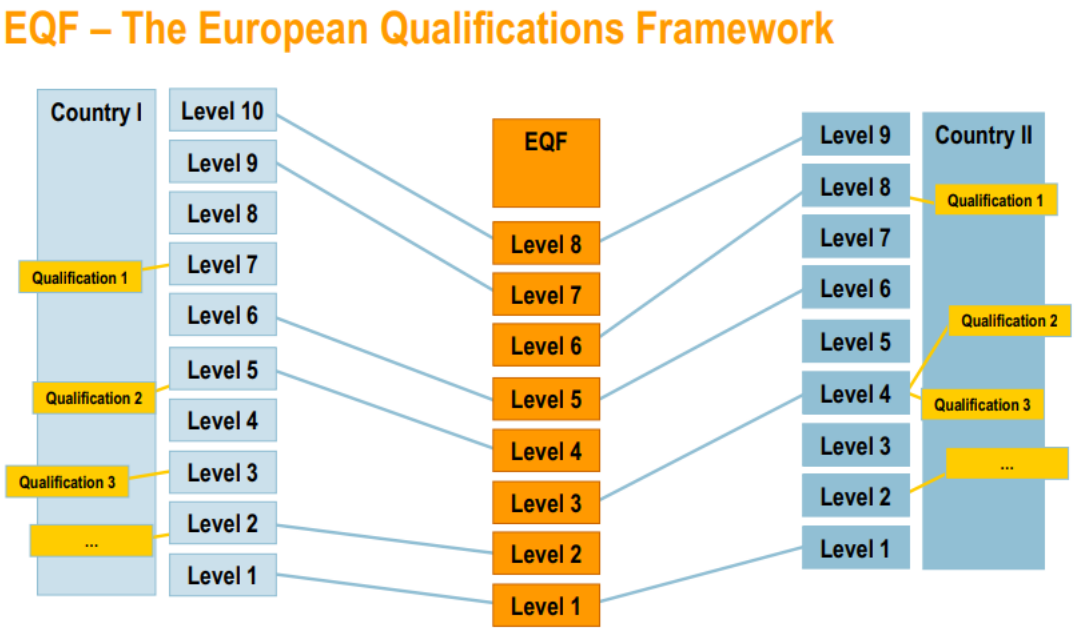

Figure 3: Exemplary alignment of different levels of NQFs to the EQF (Fietz *et al.*, 2008)

Besides the EU Member States, 11 other countries are working on the implementation of the EQF: Iceland, Liechtenstein, and Norway (European Economic Area countries), Albania, Northern Macedonia, Montenegro, Serbia and Turkey (candidate countries), Bosnia and Herzegovina, Kosovo (potential candidate countries) and Switzerland (European Union, 2017).

By harmonising the several European education systems, the transnational mobility of workers and learners across Europe will increase, bringing several benefits to the labour market by opening borders to skilled workers and facilitating international studying.

4.1.1 Technical education and vocational training

In Germany, the EQF is implemented through the German Qualifications Framework (GQF). Like the EQF it consists of 8 reference levels and is thus adopted 1 to 1. According to the GQF, the educational system in Germany starts with the vocational preparation at level 2. Within this level, several basic and advanced courses are offered and reach up to EQF level 4. These courses are designed to create and build upon a solid knowledge base. They include, but are not limited to the following: laboratory-, sewer-, microscopy-, and electrical- related topics. Reaching form level 2 to level 5, specialised courses for e.g. sewer inspection/cleaning, (Oil)-separators or specialised Electricians expand this education and training offer. Covering the EQF

levels 3 and 4, the vocational training offers in the water sector in Germany are: 1. Specialist for wastewater technology, 2. Water management specialist, 3. Specialist for pipe, sewer and industrial service and 4. Hydraulic engineer (DWA, 2018). These vocational training options are offered in a dual system, where the training is divided into a practical part, which is carried out at the employer and a block of school-based instruction.

1. Specialist for wastewater technology:
The vocational training as a wastewater technology specialist takes place in public service and in the industry over a period of 3 years. The working environment is very diverse. It comprises the monitoring of the treatment plant, sampling, and subsequent analysing of standard parameters in the laboratory as well as maintenance and repairs of technical equipment like pumps. Furthermore, maintenance and control are also part of the working area. The theoretical background regarding chemical, physical and biological processes is set in the vocational school.

After completion of the vocational training and 2 years of additional work experience, there is the possibility to become a wastewater master or technical environmental specialist, which are classified at level 6 of the EQF. Further training to become a disposal technician or environmental technician is also a possibility.

2. Water management specialist:
Within the 3-year training period, the trainees design water supply and wastewater disposal facilities in cooperation with engineers. They carry out the necessary calculations and measurements, prepare tender documents and monitor construction measures. Planning of flood or coastal protection and water body restoration measures and water protection areas is also part of the work field. Moreover, measuring and evaluating water management data is one of the main tasks of Water management specialists as well as taking water samples from several water bodies.

Further education possibilities include state-certified technician or studying in the field of civil engineering, environmental protection, or sanitary engineering.

3. Specialist for pipe, sewer and industrial service:
The work areas can be divided into pipe and sewer service on the one hand and industrial service on the other. Pipe and sewer service contains controlling the sewers of private houses for leaks or contamination by using special cameras and remote-controlled robots to seal damaged areas. In the public sewer network, they conduct routine inspections like checking pipes or basins for leaks and arrange for necessary repairs. In the field of industrial services, they empty, clean, and maintain pumping stations, tanks, tank trucks and filling plants, as well as fermentation and beverage containers depending on the particular industry. For this purpose, high-pressure water,

or vacuum suction devices to remove residues, deposits or impurities and dispose of them in an environmentally friendly manner are used.
After completing the 3-year vocational training and two years of professional activity, the master craftsman for pipe, sewer and industrial services or the state-certified technician for environmental protection technology can be obtained. Moreover, studies at the University can follow the vocational training.

4. Hydraulic engineer:
Water constructors maintain shipping lanes and non-navigable waters and their embankments. During the 3-year training they dimension construction sites and calculate flow velocities. They calculate the material requirements and draw construction plans. Main part of the work consists of inspecting, maintaining and repairing dams, regulatory structures, weirs, locks, reservoirs, and bank protections as well as coastal and island protection facilities. They carry out minor repair and maintenance work or arrange for major repairs. Measuring of water levels and depths, removing of obstacles to traffic such as flotsam and putting up navigation signs. Moreover, water constructors also ensure the protection of waterways and coastal structures in the event of a disaster. hey also monitor and supervise major construction projects.

Possible further training includes master hydraulic engineer, technician, or shift supervisor in lock operations. Given the appropriate school qualification, a degree in civil engineering, environmental protection or municipal hydraulic engineering can follow.

4.1.2 Academic education from universities (graduate and post-graduate)

The academic level of education includes EQF level 6 for Bachelor's degrees, 7 for Master's degrees and 8 for the doctorate. Students in the water sector usually obtain the academic degree Bachelor/Master of Science or Bachelor/Master of Engineering. Classic degree programmes in the water sector are civil and environmental engineering/science. These are usually broadly based and allow for in-depth study in the water sector through compulsory electives. Since environmental topics and thus also topics around water treatment and wastewater treatment are increasingly coming into focus, more and more degree programmes are now being offered that specialise in water topics. These include, for example, Water Science and Engineering, Water Sciences or Urban Water Management. Graduates from universities are responsible, for example, for the conception and planning of filter systems for the design of water treatment plants or the determination of groundwater courses for drinking water production. Here you can work in engineering offices or public administration, for example in the application, monitoring and approval of facilities that fall within the water sector. This includes wastewater treatment plants, water treatment plants, water lifting stations, etc. As water law is very complex and not uniform, legal tasks are also a

possible area of activity. Environmental and water management are other topics that fall within the remit of university graduates.

4.2 Non- and informal education

Most learning takes place outside the formal sector in everyday life and non-formal learning environments. These environments can be biosphere reserves, adult education centers, environmental education centers, social associations, sports clubs, family, circle of friends etc. Compared to the formal education it is more motivation driven because it is based on personal interests. Non-formal education or extracurricular education refers to any form of education planned outside the formal curriculum and educational opportunities for personal and social education that serve to improve certain skills and competences. It takes places in a systematic and planned manner but without the directly aiming of getting a degree or certificate. Examples are in-company education, private language learning courses, political continuing education, or continuing education in the hobby sector. It is specifically used in youth work and by many youth organizations and groups, Informal education in comparison is completely unstructured, has no institutional organization, and is not pedagogically supported or accompanied. It occurs in everyday life/work has an action or problem solving as its goal, not learning itself. Thus, is directed and controlled by the learner him/herself and is based on experience learning and it is a conscious or intentional process which is often integrated into a social context.
In Italy, most workers enter the water sector without formal training and have only non- or informal education with a training on the job approach. This leads to a strong dependence on their employer, as they lack officially recognized qualifications and certificates. This also results in reduced opportunities and mobility as they do not have the possibility to change jobs. Blending the in section 4.1.1 listed German vocal education offers with the existing non- and informal education would make the water sector more attractive for employees and thus counteract the shortage of skilled workforce.

4.2.1 Coursework for non-formal training

In Germany, the German Association for Water, Wastewater and Waste (DWA) and the Training Centre for the Supply and Disposal Industry gGmbH (BEW) offer a broad variation of courses in the water sector which can serve as an example for other countries. These courses are designed for various target groups, such as employees of water and soil associations, agencies and authorities, water supply companies, engineering offices and other companies. The lecturers come from practice, academia, or official authorities. The offer extents to certificate courses, qualification courses and short updates. The seminars are mostly offered in presence, but there are also online-

only seminars and hybrid events. Topics are broadly diversified and reach from water bodies protection to supply of drinking water and water reuse topics as well as legal affairs and sampling courses. Furthermore, technical, and electrical courses as well as occupational safety courses part of the seminars offered.

4.3 Concepts for post-graduate training of academic and equivalent staff (CAS/DAS/MAS)

In the tertiary education area, the Master of Advanced Studies (MAS), is a non-consecutive Master's degree, and is intended as further education for people with a university degree and relevant professional experience. It is mainly used in Switzerland and Liechtenstein and occasionally in Austria, but also in Germany. The structure in Switzerland and Liechtenstein is modular and is subdivided as follows:

- **Certificate of Advanced Studies** (**CAS**) (certificate level)
- **Diploma of Advanced Studies** (**DAS**) (diploma level)
- **Master of Advanced Studies** (**MAS**) or Executive Master of Business Administration (EMBA) (Master level)

In the field of environmental technology and management, the Master of Advanced Studies in Environmental Technology and Management at the University of Applied Sciences of Northern Switzerland /FHNW) is presented here as an example. The MAS consists of four CAS programmes and a MAS thesis. The time required for each CAS and the Master's thesis is 360 hours each and comprises 12 ECTS/Module. The total amount is therefore 60 ECTS. The CAS offered are Development and Environment, Health and Environment, Industry and Environment, Management and Environment, and Environmental Law and Enforcement. In addition, courses from the CAS programme Sustainable Finance can also be chosen. The CAS are then divided into individual seminars. The general modular structure is depicted in Figure 4.

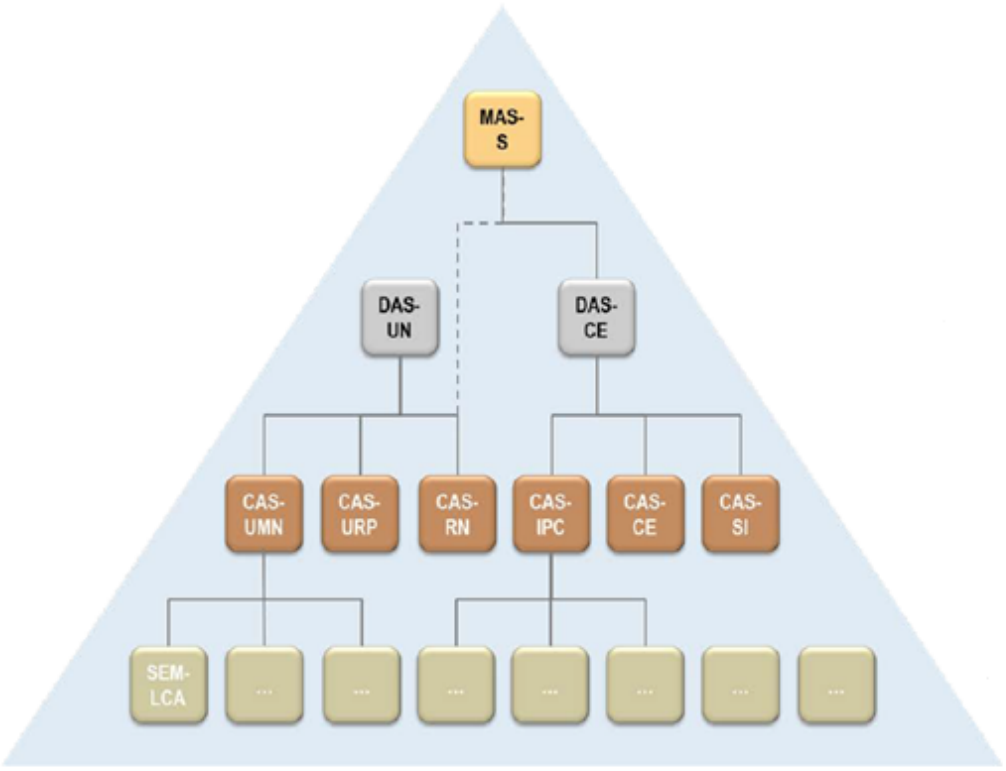

Figure 4: Proposed modular layout for post-graduate training of academic and equivalent staff (CAS/DAS/MAS) at FHNW (Kazner *et al.*, 2017)

The total participation fee for the entire MAS programme is CHF 25,000, divided into 4 CAS of CHF 5,950 each and the thesis: CHF 1,200. It is also possible to take only individual CAS. DAS are also offered in some subject areas. In this case, only 3 CAS courses are required and there is no need to write a Master's thesis.
In Germany, the MAS is classified as a "postgraduate degree programme". Contrary to the consecutive Master's degree, the MAS involves in-depth and specialisation studies (formerly postgraduate studies) with different levels.

5 Impact on and relation to other sectors

5.1 Education supporting sustainability aspects in the water sector

New education approaches also must focus on sustainability aspects. to transform the daily behaviour of individuals and communities. It is important to pay attention to the complexity of ecosystems and the water cycle worldwide. The 3 pillars of the sustainability triangle (Figure 5) social, economic and ecological goals must be brought together and a balance has to be achieved between them (Peterson, 1997).

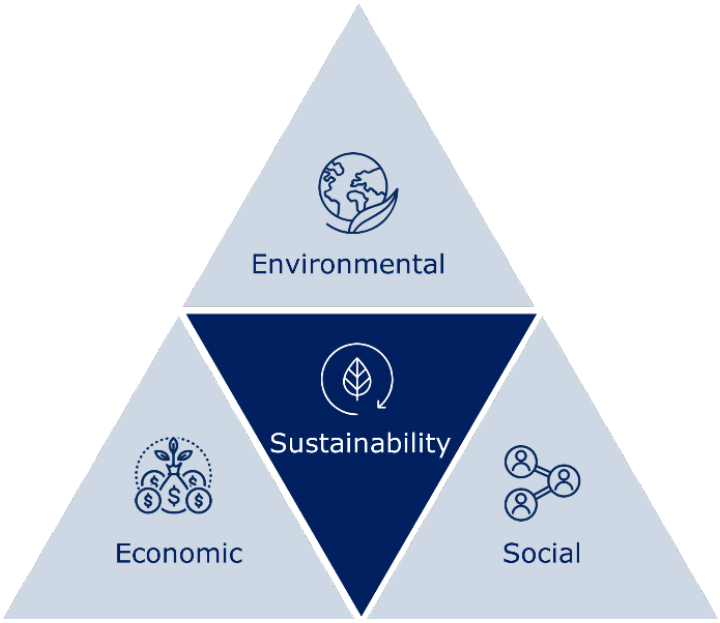

Figure 5: Sustainability triangle showing the interaction between economy, social aspects and the environment[1]

The situation of natural resource use in relation to the world's population and environmental degradation is one of the main aspects to solutions needed to achieve a more sustainable world and to reach sustainable development. According to the United Nations World Commission on Environment and Development, also known as the Bruntland Commission, the definition of sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Education supporting sustainability, needs to focus on the empowerment of learners to make informed decisions and take responsible action for the integrity of the environment and the viability of the economy (Rieckmann, 2017). To guide development policies into 2030, the United Nations have proposed the Sustainable Development Goals (SDGs) to mobilize and motivate the countries to continue their efforts in order to achieve their sustainability goals. The SDG 4 "Quality Education", directly addresses the importance of education that is needed to promote sustainable development (Martínez-Borreguero *et al.*, 2020). Furthermore, SDG 6 "Clean Water and Sanitation" sets the goal that universal and equitable access to safe and affordable drinking water for all is reached by 2030 (Moreno-Guerrero *et al.*, 2020). Education approaches in the water sector needs to start as early as possible and should be included in primary and secondary education to raise people's awareness of this crucial sector at an early stage, to create an interest base in this area. Well-trained professionals are needed to make the water sector fit for the future.

[1] https://blog.enocean.com/wp-content/uploads/2022/12/blog-12-2022-sustainability-buildings-triangle.jpg.png

5.2 Digital tools in the water sector to support (decentralized) learning

The advancing digitalization of the world of work and professions can change work fields and the requirement profiles. To build a modern framework that includes digital tools for industrial water treatment and management, it is essential to adopt a data-driven and technology-enabled approach. This involves integrating digital tools and platforms with traditional water management practices, to create a comprehensive and efficient system. The following steps can build the basis of a modern education framework:

- **Identify key digital technologies**: Identify and evaluate digital technologies that can be integrated into the industrial water treatment and management system. These may include Internet of Things (IoT) sensors, artificial intelligence (AI), machine learning (ML), and big data analytics.
- **Develop a data infrastructure**: Create a data infrastructure that can collect, store, and analyse large amounts of data generated by the digital utilities. This may involve setting up cloud-based platforms or data centres that can support real-time data processing and analysis.
- **Implement monitoring systems**: Use IoT sensors to monitor water quality, consumption, and other key parameters in real-time. This can help identify potential issues early on and enable prompt interventions.
- **Use predictive analytics**: Utilize predictive analytics and machine learning algorithms to identify patterns and anomalies in water quality and consumption data. This can help predict potential issues and optimize water usage.
- **Adopt digital communication tools**: Use digital communication tools to enable real-time collaboration and information sharing between stakeholders, such as industry professionals, regulators, and the public.
- **Develop digital training programs**: Develop digital training programs that can provide industry professionals with the necessary skills and knowledge to operate and maintain the digital utilities effectively. These tools can also be used for hybrid education and training approaches to avoid long journeys and thus save time and money.

Digitalisation in the water sector is currently still in its infancy and there is still a lot of potential that can be exploited. Below are some examples where digital applications are already being used in the water and education sector:

- Augmented reality operation to carry out plant maintenance with the help of VR glasses or tablets.

- Digital water management by using a networked wastewater treatment plant to provide real-time information on malfunctions and repair requirements.
- Predictive maintenance by using data analyses for preventive avoidance of failures and damage.
- Predictive analytics to make predictions about the amount of water in flooded areas by using automated data analyses.
- Sensor technology to maintain and check sensors on pipelines and canals; be alerted automatically to faults and malfunctions in pipelines and canals via an app based on sensor data or use sensors to measure water levels.
- Maintenance and repair robots to use for maintenance activities and to inspect sewer systems and repair partial damage.
- Digital topographic maps to locate water and sewer networks.

5.3 Financing of education in the (industrial) water sector and economic incentives

Financing of water related education programs remains a crucial part. As described in section 2, in addition to the workers, employers and the government also have a great interest in finding employees for the water sector in order to counteract the manifold problems such as the demographic development and the resulting shortage of skilled workers.
Since, in addition to low social recognition, economic attractiveness is also one of the problems that make it difficult to attract employees to the water sector, companies and governments can counteract this by expanding the funding of further training measures.
To relieve companies of the burden of financing further training, the Qualification Opportunities Act has been in force in Germany since 2019. This means that certain further training courses are funded by the Federal Employment Agency in Germany. The subsidy depends on the size of the company and the level of education of the employee and can go up to 100 % of the occurring costs for small companies or for employees without professional qualification or qualification related training. Assistance can be provided in two ways. On the one hand, the costs of further training can be covered, on the other hand, the Federal Employment Agency can cover the salary during the further training period. The main starting points is to support companies with regard to structural change and the transformation of the world of work, especially through digitalisation, so that they can act in a future-proof manner and expand the know-how and skills of their employees with suitable qualification and further training offers. In addition, the shortage of skilled workers is to be combated by securing the personnel needs of companies in order to turn even low-qualified employees into skilled workers through qualification-oriented further training.

This holistic approach can also be interesting for other countries that do not have a similar programme. It strengthens the cooperation between the two main stakeholders, the state, and the company. Furthermore, employees benefit enormously from this relief for companies, as the (partial) financing of training makes it easier to take advantage of the offer. Smaller companies, which would not be able to afford such training, benefit especially from this funding opportunity. This also applies to people without a vocational qualification due to the possibility of 100% wage continuation by the Federal Employment Agency.

6 Case Study: North Italian industrial water sector

6.1 The North Italian industrial water sector

The North Italian industry is characterized by high value products such as food and beverage, textile, clothing and leather industry, mechanical engineering and automotive suppliers, metal products, chemical industry etc. Due to the advancing globalisation and the associated opening of markets, countries with higher price structures are coming under increasing pressure. Although it has more favourable production conditions than Germany or other western and central European countries, it is falling further and further behind, especially compared to China, which is the main competitor, as are many other economies.

Like a lot of western industrial nations, Italy also struggles with the demographic change. In 2020, the EU population aged 65 and above totaled for 20% (in Italy 23%, in Germany 22%), compared to 16% in 2001, highlighting that Germany to a lower, and Italy to a slightly higher degree, is affected by an aging population (EUROSTAT, 2022). This is caused by declining birth rates and higher life expectations due to progress in medical care, hygiene, nutrition and housing, improved working conditions and increased prosperity. Thus, the replacement of the retiring workforce is a main challenge in the North Italian industrial water sector across all levels of competences, but especially for blue-collar workforce. So far, however, it has not been possible to recruit workers for the water and environment sector, as only 0.1% chose the water management and environment sector regarding vocational education, which is mainly due to low social esteem, especially in the wastewater sector, as well as insufficient pay due to the unregulated level of education.

Another problem for the Italian water sector is the late or partial compliance with the requirements of EU directives. This means that companies and water associations etc. cannot plan for the long term, as the framework conditions in which they operate can change constantly, even in the short term. This is also because, in comparison to Germany, there are no umbrella organisations that are also involved in the development of legislation and other technical regulations. Cooperation on this scale

does not usually exist in Italy and all operators in the water sector work more or less for themselves without any real, sustainable exchange of knowledge.
Since there is predominantly no vocational education and training in the water sector, the majority of the workforce, especially in the blue-collar sector, consists of lateral entrants. Most of them have learned other professions, such as mechanic or electrician, or have no vocational training at all and complete a short training course in order to have at least a minimum foundation. In some cases, they simply learn their jobs through on-the-job training. In addition to this inadequate training situation, the water sector is in a constant state of change. Beyond to the challenges posed by digitalisation, changing legislation and new technologies, as a result of the lively research activities in this field, are leading to shifting framework conditions. As a result, professionals at all levels of competence need to have a broad level of education, practical skills, and adaptability.
Here we refer to the detailed description of the North Italian industrial water sector in the **"Analysis of trends and perspectives of adult education in the field of wastewater management in Germany and Italy"** which is also part of the INADE project.

6.2 Transferability of chosen approach

The MEF must be understood as a general approach, as the country and regional differences are too great to be reflected in one framework. The approaches and recommendations listed here comprise especially the Italian and German education system and must therefore be adapted to the respective local conditions, based on the particular technical standards that applies. General statements such as legal compliance, development of digital infrastructure in education, focus on sustainability aspects and the general approach from which action planning emerges, can provide valuable guidance for most case studies and are less regionally specific.
Since the training sector in many countries in the water sector, especially in southern and south-eastern European countries, has similar problems to those in Italy, this MEF can also be used for these countries with minor adaptations or can be used as a reference point to derive sector and country-specific tailored programmes. The approach of extending the well-designed vocational training programme used in Germany to countries that have so far trained their workforce in the non-formal and informal sector should help them in the future to make the labour market more attractive, to raise the level of education and thus to counteract the shortage of skilled workers, which has worsened for many reasons.

7 Conclusions

As demographic change continues to intensify, it is more important than ever to attract new workforce to the water sector, train them well and retain them by making the sector more attractive. One way to achieve this is to bring together the best approaches from the different countries' education landscapes and then develop education programmes tailored to the respective countries and regions. The basis of every education framework needs to be derived by the EQF to ensure transparency, comparability and transferability of qualifications are.
As a general recommendation that is not only region-specific, a modern education framework for industrial water treatment and management in Europe can be developed by drawing on best practices and should contain:

- **Practical training and experience:** The framework should provide practical training and experience, including internships and apprenticeships, to equip students with the necessary skills and knowledge to work in the industry.
- **Collaboration with industry:** Close collaboration with industry professionals is essential to ensure that the education framework reflects the current needs and practices of the industry. This can be achieved through partnerships with industry associations, research institutions, and private companies.
- **Certification and licensing:** The framework should include certification and licensing programs to ensure that graduates have the necessary skills and knowledge to work in the industry and meet regulatory requirements.
- **Integration of digital utilities**: The education framework should incorporate digital tools, such as IoT sensors, big data analytics, and machine learning algorithms, to enable more efficient and effective water treatment and management practices.
- **A strong focus on sustainability:** A modern education framework should prioritize sustainability and environmental protection, reflecting the growing importance of these issues in the industry. This can be achieved by emphasizing the use of innovative and eco-friendly technologies and practices.
- **Inclusion of ethical and social considerations**: The education framework should incorporate ethical and social considerations, such as responsible water use and equitable access to clean water, to address the wider societal implications of industrial water management.

By incorporating these elements, a modern education framework for industrial water treatment and management in Europe can prepare future professionals for the challenges of the industry.

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