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REVIEW

Bioethical analysis of sanitary engineering: a critical assessment of the profession at the crossroads of environmental and public health ethics

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ABSTRACT: Sanitary engineering is burdened by several challenges that attract bioethical attention: (1) there are many ambiguities regarding the definition of the profession; (2) its methodology seems to be a combination of several approaches from different sciences; and (3) it often appears to be an amalgam of different disciplines. We argue that the bioethical perspective helps to show that these features can be taken as a stimulating challenge. Moreover, bioethics may illuminate how these features can become an asset to sanitary engineering in light of the growing need for holistic approaches. First, we present a bioethical analysis of the aforementioned features as a useful way to clarify and strengthen the identity of the profession. Second, we argue that professional ethics have received the least attention, but are crucial to giving the profession stronger independence and professional identity and to creating a unique worldview at the crossroads of environmental and public health ethics. Finally, we propose a general framework of sound professional ethics of sanitary engineering as a necessary step towards rethinking the core values of the profession, clearly articulating a genuine professional ethic, and reforming educational politics related to professional education.

KEY WORDS: Sanitary engineering · Bioethics · Professional education · Environmental ethics · Public health ethics

1. WHAT IS (THE PROFESSION OF) SANITARY ENGINEERING?

When we discuss sanitary engineering, it is not clear to the general public what we are talking about: even at the level of the name, there is a lot of confusion. In different countries, people at the core of the profession have different names, including 'environmental health officer', 'environmental health practitioner' and 'sanitary engineer' (European Commission 2021a); followed by inappropriate and inadequate job descriptions, such as 'health worker' or 'engineer' (Previšić 2017). In Croatia, for example, the profession falls under the health domain (Narodne novine 2009, 2019), whereas the European Union lists it under environmental health professions (European Commission 2021a). For the moment, we will put aside the terminological issues and use the term 'sanitary engineering' despite the similarities with alternative nomenclature and professions such as 'public health engineering', 'environmental engineering', 'bioenvironmental engineering' or 'environmental health engineering' (Nathanson 2016; cf. Thomas 1956). We also agree with the thesis that there is no need for further subspecialization in this branch of engineering, but that all of these designations should

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stand for a very broad, interdisciplinary profession (cf. Gelting et al. 2019).

Reasons for considering sanitary engineering as a true profession are many. Although too much ink is spilled in defining what the profession is — and there has been some critique of defining the term 'profession' as a term with a fixed meaning (cf. Dingwall 2008, p. 11–15), or taking 'professionalism' as 'a static phenomenon rather than the dynamic process' (Elliot 1972, p. 5) — some exact general characteristics or attributes of every profession should be used as a practical tool to study professions, including that of sanitary engineering. The social sciences, especially sociology, offer some appropriate tools for such a preliminary analysis. Thus, we could provisionally examine sanitary engineering through the view that the profession must consist of 5 important elements: (1) theoretical and methodological foundations for professional action as a whole; (2) monopoly on professional expertise; (3) public recognition; (4) organisational structure; and (5) professional ethics (Šporer 1990). First, the profession is defined (theoretically and methodologically) in most countries by specific laws, guidelines and other documents. Second, there is quite a demand for professionals from the fields involved in public health work, such as institutes of public health, food industry, waste management industry, tourism, public sector and ecological and epidemiological sectors, among others (Racz et al. 2011). Third, the foregoing gives the profession a prominent place in public perception and appropriate recognition. The best argument for this and a clear description of differences between the meanings of 'health' and 'sanitary' in the professions of sanitary engineering and environmental health engineering was offered by Thomas (1956). Fourth, the profession is organised at various levels (Boyce 1950): professional (chambers or associations; some examples from Europe include The Chamber of Sanitary Engineers of Slovenia – Institute of Public and Environmental Health, European Public Health Association, Environmental Health Association of Ireland) and at the educational level (curricula from high schools to university programmes; in Croatia, for example, there are differences between study programmes and courses at the university and professional levels). Fifth, at least at the formal level, some elementary principles of professional ethics are prescribed (cf. Hrvatska komora zdravstvenih radnika 2021).

Despite the visible contours of the first 4 professional characteristics of sanitary engineering, there is quite a lot confusion in defining the profession. Therefore, we will summarise these ambiguities as a first step towards clarifying the identity of the profession, and argue that these characteristics yield an interesting cluster of bioethically relevant attributes of the profession of sanitary engineering. Here, we will draw on the findings of social sciences: first and foremost, we will consider the sociology of professions as a tool for analysing the nature of sanitary engineering as a profession.

In further analysis, we will show that the last point, i.e. professional ethics, has received the least space and attention, arguing that it is deeply rooted in the traditional principles of public health ethics (Brennan & Lo 2016) and environmental ethics (Des Jardins 2013), and as such is the crucial element to give the profession a clearer identity. In this section, we will first show the core value of the sanitary engineering profession by analysing examples of ethical codes. We will then demonstrate the essential interdisciplinary nature of the profession using examples from various established sources for the profession (textbooks). Finally, we will demonstrate the main theses about the profession using the Croatian curriculum for the education of sanitary engineers as an example.

With the aim of doing justice to the unjustly neglected topic of professional ethics, we will propose how to create a solid ethical framework for the profession of sanitary engineering, which at the same time represents a unique opportunity to strengthen its professional identity. We will critically analyse the features of public health ethics (Brennan & Lo 2016) and environmental ethics (Des Jardins 2013) that are relevant to sound professional ethics for sanitary engineering. Given the nature of the profession and the interdisciplinary requirements of its activities, we will suggest that it is necessary to take a comprehensive bioethical view and consider some essential imperatives related to public health ethics and environmental ethics as inextricably linked to the sanitary engineering profession. Moreover, we will suggest that this point is the stronghold for compelling professional ethics that can simultaneously provide a stronger professional identity for sanitary engineers.

2. CLARIFYING THE IDENTITY OF THE PROFESSION — PRELIMINARY BIOETHICAL CONSIDERATIONS

The terminological confusions about the name of the profession were discussed in Section 1. Here, we will point out some further obstacles to a unified view of the identity of the profession. Specifi-

cally, we will reveal some problems concerning the first 4 professional characteristics of sanitary engineering, which we already introduced in Section 1: (1) theory and methodology, (2) monopoly on professional expertise, (3) public recognition and (4) organisation of the profession.

2.1. Theoretical uncertainties and methodological indeterminacies

There has been a common uncertainty in the determination of the profession throughout history, even among those who practice the profession (cf. Dallyn 1922, Fuller 1925a, Heiser 1927). We should begin with a possible content determination of the profession according to (Šverko 1999):

> 'Sanitary technicians and engineers work to identify pollution, radiation, noise, and other environmental factors that interfere with the health. They propose and implement appropriate measures to maintain people's health. The subject of their analysis is everything that surrounds people and that they use: water, soil, air, food, living and working spaces, hygienic materials and objects of general use'

The essential content determination, or definition of the subject, seems to concentrate on the environmental conditions that have an impact (positive or negative) on human health. Such a determination can be found in various laws and documents concerning the profession, but it is very broad and bears an interesting resemblance to bioethics in general, or life sciences and health care in particular. The entire profession revolves around the concept of health, as it involves the control of pollutants, defined as 'a substance that has a demonstrated adverse effect on human or ecological health' (Reible 2010, p. 1), and the defining activity of the profession is 'the application of engineering science to the analysis of environmental processes and effects and the design of control systems designed to minimize adverse effects on those processes' (Reible 2010, p. 3).

Such breadth in a professional field could pose real problems. Bioethics is a prime example of concerns related to disciplinary breadth, and there have been many repeated attempts to limit its content to practical ethics (Kuhse et al. 2016), biomedical ethics (Beauchamp & Childress 1979, Kuhse & Singer 2004) or medical ethics (Veatch 2003). However, the most prominent stance in the bioethical community is that the broad content and diversity of manifestations and approaches to life as such should be preserved as an asset that has produced such a uniquely rich and planetarily widespread development of the discipline of bioethics (see Eterović 2017, especially Chapter 1). However, methodology is the key for the discipline: this is probably best seen through changes and shifts in 'official definitions' of bioethics in all 4 editions of the 'Encyclopedia of Bioethics'. The first definition laid out the widely accepted broad subject of bioethics: 'healthcare and life sciences', which was also included in the second edition, which differs only in its expansion of methodology by 'employing a variety of ethical methodologies in an interdisciplinary setting'. The third edition followed the second, reiterating the need of such an expansion, but in the latest, fourth edition, there is a trace of reversion to the first definition, which may imply a tacit call to narrow the methodology and consequently the field of bioethics (cf. Reich 1978, p. xxxii; Reich 1995, p. xxi; Post 2004, p. xi; Jennings 2014, p. xv).

Methodologically, sanitary engineering has no single methodology, but is *a priori* interdisciplinary and depends on many sciences and disciplines (Gelting et al. 2019). Examples of the broad understanding of the profession's methodology can be found in numerous compendia and textbooks on sanitary engineering or environmental engineering. For example, professionals in this field 'have expertise in drinking water and wastewater treatment, air quality engineering, groundwater engineering, solid and hazardous waste management and remediation, surface water quality, environmental chemistry, ecology, and assessing environmental risk' (Mihelcic 1999, p. iv) stressing further that the profession of environmental engineering draws upon many disciplines, including civil, environmental, chemical, mechanical and geological engineering; geology; chemistry, microbiology; toxicology; atmospheric sciences; meteorology; and ecology. The civil engineering profession encompasses many specialty areas (i.e. structural, geotechnical, water resources, transportation, construction management, environmental) (Mihelcic 1999).

The reason for this is that '[t]oday's environmental problems are complex and are no longer confined to one particular medium', and the profession is considered the 'field in which one applies the basic fundamentals of mathematics, physics, chemistry, and biology to the protection of human health and the environment' (Mihelcic 1999, p. 2). While dealing with technical issues of controlling pollutants, in addition to these, the sanitary engineer should keep in mind 'the legal, societal, political, and economic issues' (Reible 2010, p. 3).

What then is the role of a sanitary engineer? The answer is quite analogous to bioethics – the engineer's role is to integrate such diverse perspectives to achieve the defining goal of the profession. In the words of Reible (2010, p. 2–3):

> 'An environmental engineer would, however, be expected to have a greater understanding of the environmental impact of engineering activities than traditionally trained engineers. In addition, the environmental engineer should exhibit a greater understanding of the availability and feasibility of control and waste minimization technologies than an environmental scientist. Thus an environmental engineer serves in an integrating role meshing traditional engineering activity with environmental concerns. [...] The greater breadth of the ideal environmental engineer encourages them to see on both sides of the fence. It is from this perspective that the environmental engineer may be best able to resolve environmental issues while balancing all external constraints, whether they be technical, economic, or societal constraints such as moral, political, or legal constraints'

The public health perspective and the technical perspective integrate all other perspectives necessary for the protection of human health from various pollutants through the profession of sanitary engineering. This methodological breadth gives these professionals and bioethicists a common language, or sense, of the need to integrate different perspectives and disciplines to solve the problems centred on health (also the common objective), and consequently the quality of life. The holistic approach to health, society and the environment is characteristic of both bioethics and sanitary engineering.

2.2. Certain characteristics of the profession: expertise, public recognition and organisation

All 3 of the other characteristics of the profession of sanitary engineering are more obvious and there is clear evidence to support them, so they will only be summarised briefly here without further elaboration.

There is no doubt that the profession of sanitary engineering today is a well-rounded profession. The profession has precise curricula for different levels of education, a specific field of work and various employment opportunities (at least in most developed countries). The education of sanitary engineers has a long tradition, and the profession has more than half a century of history with distinguished centres for education and training at universities such as Harvard, Baltimore, Michigan, California and North Carolina in the USA (Thomas 1956) or Leeds and Loughborough in the UK (Gelting et al. 2019). There are also textbooks and manuals for the profession (see e.g. Mihelcic 1999, Reible 2010) and a widespread network of scientific and professional conferences: from the first International Conference on Sanitary Engineering in 1925 (Fuller 1925b) to the regularly organised International Conference on Sanitary Engineering, Water Quality and Solid Waste Management (World Academy of Science, Engineering and Technology 2021). There is thus ample evidence to suggest that a distinct profession has emerged.

These professionals are widely recognized and fully respected as the 'extended arm' and 'extra eyes and ears' of physicians (Mićović et al. 2007), as they are always in the field and are much better informed about the external circumstances; at the same time, they have enough knowledge and skills to conceptualize, recommend and sometimes even design immediate public health solutions on the spot. They are an indispensable part of modern public health and their role 'is important in many aspects of public-health practice', despite the fact they are often 'regarded as being in an ancillary position to the medical profession when the entire science of Public Health is considered as an entity' (Thomas 1956, p. 2).

Finally, in organisational terms, sanitary engineers have professional chambers and societies (such as The Turkish Society of HVAC and Sanitary Engineers; The American Society of Sanitary Engineering; County Sanitary Engineers Association of Ohio; Philippine Society of Environmental and Sanitary Engineers; The Society of Heating, Air-Conditioning and Sanitary Engineers; Association for Water Technology and Sanitary Engineering) and a structured hierarchy of education, training, licensing and professional advancement. The problem in some countries, e.g. Croatia, is that the small number of these professionals, compared to nurses, for example, has produced some very strange solutions in their professional organisation. The most striking Croatian example is the joint Croatian Chamber of Health Workers, where different professions are grouped together in one 'pot' that includes sanitary engineers, radiology technicians, occupational therapists and medical laboratory diagnosticians (Hrvatska komora zdravstvenih radnika 2012). Consequently, these professions have a common Code of Ethics (cf. Hrvatska komora zdravstvenih radnika 2012), which is absurd given the specific field of work of each profession,

and especially the breadth of the profession of sanitary engineering.

3. BIOETHICAL ANALYSIS OF SANITARY ENGINEERING

Several important bioethical insights are highlighted in this brief account of the characteristics of sanitary engineering. (1) At the level of the definition of the profession, there is much ambiguity, demonstrating that the profession needs a broader framework for contextualising the issues it addresses, which is very similar to the bioethical worldview that relies on using as many disciplines and perspectives as possible. (2) Methodology deepens the first insight by showing that the profession, much like bioethics, is a combination of several particular methodologies and approaches from different sciences and disciplines, but is somehow connected with a unique guiding thread and unique integrating role of all of these disciplines. (3) Finally, like bioethics, the profession sometimes appears to be an amalgam of different sciences and disciplines, rather than a distinct, clearly defined discipline, but its professional competence, public recognition and organisation clearly argue against this view.

We will argue that after these initial findings from a bioethical perspective on sanitary engineering, we can show that these 3 characteristics should be seen as a challenge, rather than a problem for the profession. We argue that bioethics, through its own experience of the development of the discipline, could shed some light on how these 3 characteristics can become an advantage of sanitary engineering in a world of increasingly complex issues that cannot be adequately studied with a monoperspective approach, but require a holistic approach.

Our analysis is carried out in 3 steps: illuminating the core values of the profession (Section 3.1), explicitly articulating the interdisciplinary nature of the profession (Section 3.2) and elaborating on the genuineness of the professional ethic (Section 4).

3.1. Basic value of the profession: health

That human health and well-being is a fundamental and core value of the profession is already evident from the first pages of the ethical code (Croatian examples; translated by the authors):

'A health worker's [...] honorable duty is to devote his/her activity to the health and well being of man.' (Hrvatska komora zdravstvenih radnika 2012, Section 3.1.)

'A health worker [...] will respect citizens' rights by considering the welfare of citizens as their first and primary concern.' (Hrvatska komora zdravstvenih radnika 2012, Section 3.4.)

'The health worker [...] is in the performance of his call independent within the limits of his/ her qualifications and for his/her work is responsible in front of his/her conscience and society.' (Hrvatska komora zdravstvenih radnika 2012, Section 5.1.)

In general, the ethical guidelines of engineering reflect a high ethical responsibility towards society. Oakes et al. (2009, p. 398) emphasize that:

> 'While performing services, the engineer's foremost responsibility is to the public welfare. [...] Engineers shall approve only those designs that safeguard the life, health, welfare and property of the public while conforming to accepted engineering standards'

Health in the sanitary engineering profession is understood in a much broader sense: from the epidemiological to the educational level. This requires breaking away from a particular sub-field, and — precisely because of its inevitable interdisciplinarity — the sanitary engineering profession presents itself as a profession that has bridged this broad understanding of concern and care for human health.

Health is clearly seen within the broad framework of the public health paradigm, which takes the World Health Organization's definition of health very seriously, and takes into account all 3 elements in consideration of health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (World Health Organization 2020, p. 1). Some bioethicists saw this feature of public health as an important ingredient for a rich public health ethics that takes a broad approach and becomes bioethically relevant as an area that can return bioethics to its origin by uniting biomedical ethics and environmental ethics in an integrated bioethical worldview (Lee 2017). We will return to this point, but before we do, we will elaborate more on the interdisciplinary nature of sanitary engineering.

3.2. Integrating a wide range of knowledge and skills: interdisciplinarity as a prerequisite

We have already presented the variety of disciplines that are part of the sanitary engineering profession, but the best way to point out the inevitable

interdisciplinarity is probably to present the curricula for professional education. The interdisciplinarity of the profession is undeniable; the profession incorporates different types of knowledge: from the theoretical to the practical to the technical. The profession also deals with different sciences and disciplines, including natural sciences, technical (engineering) sciences, biomedical and health sciences, biotechnical sciences, social sciences and humanities.

This type of professional education is deeply rooted in the highly interdisciplinary nature of the profession and the need for a broader perspective. Reible (2010, p. 7) writes:

> 'The environmental engineer must always strive to see broad implications of his and others' work on the environment. Focus on the components of a problem rather than its broader implications has led to many of the environmental problems we encounter today. […] A better recognition of the broader implications of an engineering activity is one of the foremost objectives of an environmental engineer'

This diversity of included disciplines gives the impression that sanitary engineering is just an amalgam of parts of these disciplines. Although there is much truth to this thesis, it should not be used as a basis for stripping sanitary engineering of its title as a distinguished and respected profession. We will attempt to show this through a discussion of the responsibilities and ethics of the profession, but before that, a good introduction is a suggestion of the desirable character traits of a sanitary engineer (Šverko 1999):

> 'The work of sanitary technicians and engineers requires a high degree of conscientiousness and responsibility in carrying out all tasks from sampling to writing reports because omissions may have major and long-term consequences for human health. Communication is important in their work. They, in fact, often work in teams and contact many people from different professions and different levels of education. Emotional maturity and ethics will help them to prevent and successfully deal with possible conflicts. Sometimes they have to evaluate on the spot what measures are to be taken and make difficult decisions, such as a ban of work'

Three elements should be highlighted here. First, a high level of conscientiousness and responsibility is required of professionals. Second, emotional maturity is a preferred trait for a good professional. Third, critical thinking is needed for on-the-spot evaluation and decision making.

Combining the first 2 characteristics of the profession, i.e. theoretical/methodological ambiguity and the highly desirable interdisciplinarity, it becomes obvious that the greatest challenge of professional education and training is unavoidable. This is probably the reason for so many inconsistencies and incompleteness in curricula for sanitary engineering. For example, The Dublin Institute of Technology (Ireland) offers the opportunity to become an environmental health officer with a 4 year Bachelor's degree, and an active postgraduate Master's programme focussed on 'wide and varied links between the environment and human health' (Technological University of Dublin 2022). They also cover a wide range of interdisciplinary subjects including: 'Biology, Chemistry, Physics, Built Environment, Environmental Science, Environmental Health Management, Food Safety, Quality and Environmental Law' (The Health Service Executive 2019). At the University of Rijeka (Croatia), the Faculty of Medicine study programme for sanitary engineering is for 3 years as part of the Bologna process of education (EU countries). On the other hand, at the National University in the Philippines, you need 4 years to obtain a Bachelor's degree in the subject, and then you can start a one-year course of 'professional specialization' (National University 2019). A Master of Science degree in sanitary engineering at the IHE Delft Institute for Water Education in the Netherlands requires 1.5 years (IHE Delft 2021).

3.3. The Croatian case study: from educational to professional pathway

For an even clearer example, we can have a look at the Croatian example of education required for the profession of sanitary engineering. If we try to determine the features of the profession based on the Croatian curriculum, we must consider the activities included in the programme. According to the provisions in the central database of the European Commission, the Bachelor of Sanitary Engineering covers a number of activities, including: those of environmental health and health supervision; those within the hygienic-epidemiological team, health ecology and pest control; health education of people who work with food and consumer goods; organisation of hospital hygiene and nutrition; procedures of sterilization; physico-chemical and microbiological analysis in laboratories for the analysis of food, water, consumer items, soil, waste, air and ecotoxicology; analysis of living and working environments; tasks in the production, transport, use and disposal of toxins; assessment of the potential adverse impacts on the environment; implementation of the quality systems for food, laboratory, environment and occupational health and safety (European Commission 2021b).

According to the same regulations, a Master of Sanitary Engineering: (1) performs sanitary control; (2) participates in the production, processing, packaging and distribution, preparation and utilization of safe and nutritious food; (3) works within hygiene and epidemiological teams in the units for microbiological analysis of food and items of general use, the units for the chemical testing of food and items of general use, the units for microbiological and chemical testing of surface and waste water, water for drinking, sea water and water for recreation, the units for testing waste, soil, air and ecotoxicology; (4) works with techniques and the application of molecular biotechnology in order to control the possible risks of using them in units for the implementation of measures for disinfection, pest and rodent control (disinfection, disinsection, deratisation); (5) works in the production, transport, use and disposal of poisons and other dangerous substances; (6) implements measures for food safety and hygiene, the protection of nature and environment; and (7) implements and monitors sanitary and technical measures of protection and sanitary control (paraphrased from European Commission 2021c).

Despite the broad, but more or less precise definition of the competences required for both Bachelor's and Master's degrees in this profession, Croatia lacks uniform curricula for the different schools at the national level. Moreover, the study courses are offered at different institutions of higher education, namely the University of Applied Health Sciences in Zagreb and the Faculty of Medicine at the University of Rijeka (cf. University of Applied Health Sciences 2021, University of Rijeka Faculty of Medicine 2021a). Here, we will focus on the study programme at Rijeka's Faculty of Medicine.

The courses from the different years of both undergraduate (University of Rijeka Faculty of Medicine 2021a) and graduate degrees (University of Rijeka Faculty of Medicine 2021b) show some very interesting features that warrant at least 3 important comments, keeping in mind some general features of professional education in sanitary engineering (cf. Mendelsohn 1924).

First, although sanitary engineering in Croatia belongs to the health profession, undergraduate studies are clearly dominated by natural sciences, and graduate studies are dominated by (bio)engineering sciences.

Second, the professionals who are considered 'the extended arm' and 'extra eyes and ears' of physicians (Mićović et al. 2007), first and foremost epidemiologists, in the field, right in the middle of actual public health happenings, have just one course of epidemiological practice during the entire time of study.

Third, if we consider health in the broadest sense of the profession, the number and variety of courses that are required from the humanities and social sciences are ridiculously small. Even to capture the conceptual breadth for adequate system modelling essential for sanitary engineering and the public health professions in general, the environmental sciences are not sufficient, and at least some kind of environmental ethics (e.g. social ecology) course should be included. On the other hand, given the vast horizon of responsibility towards people (community) and their environment, it is absurd to have just one course in bioethics during the first year of study. We provide a brief summary of this analysis in the form of the distribution of courses by scientific area in Table 1.

From this brief presentation, it is clear that sanitary engineering is a specific profession with specific curricula, despite the different terminologies, but we point out that there is still much room for further development. From a bioethical point of view, the weakest feature of the profession seems to be the professional ethics code, which is formalized without any content-related analysis for the purpose of education, as we will show in a further and final step of our analysis.

Table 1. Division of courses by scientific field at the University of Rijeka, Faculty of Medicine – Sanitary Engineering, Croatia (Nacionalno vijeće za znanost 2009, University of Rijeka Faculty of Medicine 2021a,b)

Academic year	Number of courses					
	Natural sciences	Biomedical sciences	Social sciences and humanities	Engineering and bio-engineering sciences	Practicum	Total courses per year
I Undergraduate	5	2	4	0	0	11
II Undergraduate	5	3	4	1	0	13
III Undergraduate	1	4	0	5	1	11
I Graduate	0	3	0	11	0	14
II Graduate	0	1	2	6	0	9

4. BUILDING A SOUND ETHICAL FRAMEWORK FOR THE PROFESSION: AT THE CROSSROADS OF ENVIRONMENTAL AND PUBLIC HEALTH ETHICS — PROPOSALS FOR THE DEVELOPMENT OF THE PROFESSION

The subject of sanitary engineering draws attention to public health concerns on the one hand and to environmental concerns on the other.

Sanitary engineering addresses some elementary topics from public health ethics such as (1) the public or collective good, (2) the emphasis on prevention, (3) the implications for government action and (4) the consideration and reduction of consequences (cf. Faden & Shebaya 2016).

In the classic public health paradigm, which takes the community as the targeted unit of action, the profession is primarily concerned with the public or collective good. Moreover, as a public health profession, sanitary engineering needs to broaden the targeted subject and take into consideration the whole environment, bearing in mind the complexity of today's large-scale environmental processes that pose health risks, such as climate change, population growth and urbanization (Frumkin & McMichael 2008). For such challenges, public health professionals, including sanitary engineers, need long-term thinking, systems thinking, effective framing and communication of the issues, the ability to take a leadership role in the health sector and the ability to recognize opportunities for co-benefits. Frumkin & McMichael (2008) elaborated on all 5 characteristics and provided extensive literature for further analysis.

There is also a clear emphasis on prevention. The profession focusses on the promotion of health an d tpention of individual and community illness, the control of harmful f act in accordance with legislation and the education of the public. The aspiration of professionals is to be able to actively work on health promotion and disease prevention, which are the essence of all public health professions, and one of the most important ethics specifics of public health (Callahan & Jennings 2002).

'Implications for government action' is an important aspect of the profession. Given the interdisciplinary nature of the profession, and the central goal of preserving health, sanitary engineers should always keep the big picture in mind, and be aware that legislative acts, norms and regulatory requirements that relate to the subject do not come exclusively from the health sector but from a range of interdisciplinary activities and the interconnectedness of various sectors such as economy, transport and tourism (Fox 2001). The sanitary engineer has the task of considering all of these dimensions when making a recommendation to epidemiologists and policy makers.

An important feature of the profession is also its attitude towards consequences as a natural standpoint of any public health profession. Sanitary engineers are concerned with consequences in the prevention of disease (with the goal of preventing the development of disease); in controlling the quality of air, soil or water (with the goal of checking the level of risk of some substances to human health or the health of the ecosystem on which people depend); and so on.

On the other hand, the profession is closely related to important topics of environmental ethics. We will address the most prominent ones: (1) protection and sustention of clean natural resources, (2) protection and assessment of environmental impacts, (3) waste management and (4) ecological food production (cf. Des Jardins 2013, Brennan & Lo 2016).

Work on protection and maintenance of clean natural resources (water, air, soil) is the core activity of sanitary engineering. Although the profession is often seen as part of the biomedical paradigm, the new public health challenges simultaneously consider environmental health and conservation (cf. Kessel & Stephens 2011). Moreover, there is some compelling evidence that biomedical and environmental ethics could be strong allies in their joint action (Gruen & Ruddick 2009).

The protection of natural resources refers to the circular system mentioned earlier, in which humans play a role in the preservation of these resources in 2 ways: for themselves and for the environment, being a user of these natural resources, but also with the possibility of negative impacts on the polluted environment. In this context, the protection and assessment of environmental impacts is an important part of the profession because, in the comprehensive vision of health, the sanitary engineer should necessarily take into account all relevant dimensions of the possible increase in the quality of life of the population in terms of the quality of environmental health as a prerequisite for the health of the community. Due to the complexity of environmental processes that greatly affect human health, it is imperative that the public health professions expand the target object from the community to the global ecosystem. In such a framework of 'ecological public health', health professions are called upon to embrace this complexity and 'think and act ecologically if they are to help reshape the conditions that enable good health to flourish' (Lang & Rayner 2012, p. 4).

In terms of the broad education, the sanitary engineer is probably the most educated professional in waste management. This dimension goes hand in hand with the previous one: by working on recycling and wise waste disposal, the profession has a direct impact on providing the right answers to one of the most important modern environmental problems, especially in highly urbanized areas.

Ecological food production is also part of the profession's area of expertise. Given the richness of laboratory knowledge and practical work in the field of food sample testing, by working on minimal sanitation requirements these professionals simultaneously promote the production of food of the highest possible quality, as it can affect human health. Thus, sanitary engineers make an important contribution to the evolving bioethical discussion on food ethics (Van Horn 2014) and closely related environmental health ethics (Resnik & Elliot 2014).

Putting all of this information together, we arrive at an intertwined and interconnected web of professional duties that covers the most important aspects of public health ethics, but at the same time the most vital environmental concerns that are also closely related to environmental health engineers (cf. Cassel et al. 1970; our Fig. 1).

The profession of sanitary and environmental engineering has been active since ancient times under different names in a wide range of tasks: from the protection of the population from negative environmental impacts, to the prevention of diseases and the protection of the environment from negative impacts of humans, to the concern for the quality of life and the improvement of the living environment, which clearly shows that the profession is a bridge from public health to environmental health.

Moreover, it seems that the public health professions, and sanitary engineering in particular, which also incorporates practical work in the field, hold a unique position in the modern world to bring back the original idea of bioethics, by integrating the principles of public health and the ideas of environmental ethics into an integrated bioethical worldview. Through public health ethics, this worldview can potentially 'bridge the gap between individual-based biomedical ethics and environmental ethics by bringing into conversation the diverse range of value it embraces', as the only way to come to 'an ethics that moves all of Earth's inhabitants toward a good life' (Lee 2017, p. 9–10). Lee (2017, p. 9) made this idea of her vision of the role of public health ethics very clear:

> 'I'm suggesting that that bridge, in many cases, could be public health ethics, a field that overlaps on one hand with biomedical ethics — with its focus on health of individuals — and on the other with environmental ethics — with its focus on the relationship between the health of the environment and the health of humans. Public health ethics, with its broad and inclusive framework, can help us recognize how the health of humans is intricately linked to the health of the planet'

This way of looking at public health ethics offers the possibility of a unique value orientation that is highly relevant to the original idea of bioethics, namely the integrative care of all life (Callahan & Jennings 2002, Beever & Whitehouse 2017). Among other things, it also commits bioethicists to work hard to (1) provide a clear code of public health ethics, (2) implement high quality public health education tailored to the challenging issues of modern public health concerns, and (3) encourage the development of public health ethics as part of academia (Callahan & Jennings 2002).

We can conclude with a brief summary of the possible framework for sound professional ethics of sanitary engineering. From the curricula, it appears that professional duties are fairly clear, but a future code of professional ethics should clearly include the following: (1) moral norms or duties to the community

Fig. 1. Ethical aspects of sanitary engineering, based on a description of the profession (our work, based on text from Narodne novine 2009)

(e.g. imperative for the improvement of public health); (2) ethical duties to individuals in day-to-day relationships in field work and communications (e.g. trustworthiness and transparency of work); (3) responsibilities to the environment that override some individual preferences (e.g. protecting water sources and promoting natural fertilizers).

We also point out that a solid code of ethics that takes into account all ethical dimensions mentioned above is not enough. The broader bioethical sensitivity to the interconnectedness of all of these relationships between public health and environmental concerns should be considered. This means that the complexity of the professional activities of sanitary engineering requires other dimensions of articulation of these ethical concerns, primarily through education and related educational policies. In particular, the required interdisciplinarity of the profession must be accompanied by an appropriate multi-perspective approach to the design of curricula for future sanitary engineers, taking seriously the inevitable need for social sciences and humanities in the acquisition of the required competencies of sanitary engineers. Bioethics, public health ethics and environmental ethics are first-rate courses in such curricula, and the results of the activities of movements such as social ecology, land ethics, and 'ecosophy' are excellent examples of the knowledge and wisdom that sanitary engineers need in the demanding web of responsibilities that lies ahead.

As in some other fields and professions (such as medicine), sanitary engineering requires some kind of thorough rethinking of core values and professional duties, followed by a clear formulation of genuine professional ethics, and topped by a complete reform of educational policies related to professional education. Our efforts in this article are aimed at taking a step towards accelerating these processes.

5. CONCLUDING REMARKS: GENUINE NORMATIVITY AS A PROFESSIONAL ADVANTAGE OF SANITARY ENGINEERING

Despite the initial ambiguity regarding the methodology and theoretical outline of the sanitary engineering profession, it has been shown that this is mainly due to the complexity of the profession's goals and the almost unique need for highly developed interdisciplinarity. We have shown that this could be used as an advantage and, similar to bioethics, a specific, far-sighted, long-term and critically balanced approach could be provided by the nature of the profession's subject matter, i.e. health, and by the profession's methodology, i.e. interdisciplinarity and inclusion of other perspectives.

Public health ethics is part of the sanitary engineering profession which gives the profession a special role and importance in the modern world and makes it probably one of the most important allies in returning bioethics to its original ideas of caring for all living beings and their environment. Such ideas can be found in the writings of both 'fathers' of bioethics — Van Rensellaer Potter (Muzur & Rinčić 2019) and Fritz Jahr (Rinčić & Muzur 2019) — and they have obviously taken root again in a modern and broad understanding of bioethics as a discipline.

In this way, the sanitary engineering profession has built its identity in unique ethics, giving it a strong foothold for recognition as one of the most important professions in today's world of pressing, globally threatening problems. The ethics of public health in general, and the ethics of sanitary engineering in particular, point to a possible direction for the treatment of people, society and the environment that may be the only promising worldview for the survival of the entire web of ecosystems with humans as integral components. The profession of sanitary engineering is the bearer of such an awareness and has enormous potential to play an exemplary role in adequately addressing the interconnectedness of all life on earth through very practical approaches, scientific accuracy, humanistic ideals and ecological values. The activities of sanitary engineering show in a unique way that they focus primarily on human health while incorporating societal and environmental concerns. The profession's specific focus on public health thus expresses the need to understand the interrelationship between environmental and societal issues when attempting to improve or protect human health (Fig. 2). The profession should develop a specific professional ethic, obviously based

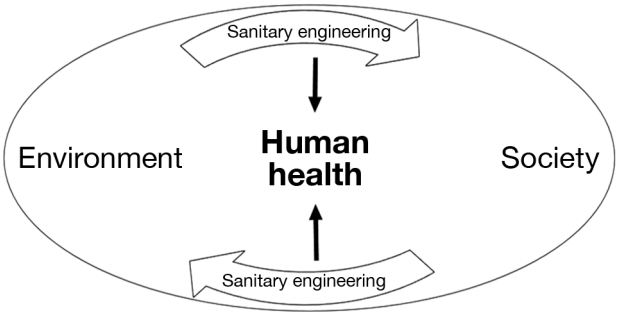

Fig. 2. Interrelatedness of environment and society for human health concerns reflected in the professional activities of sanitary engineering

on the intersection of environmental and public health ethics, thus becoming one of the most important features of its professional identity.

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