

# On the Extent of Environmental Health\*

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## Abstract

**Background:** Main purpose of this article is to offer information, criteria and conceptual proposals that could clarify the extent or scope of environmental health, and systematize the approaches for its institutional stewardship by environmental health services. Hopefully, it will be useful to managers, professionals, technicians and academics involved in the management, implementation, teaching or research of this multidisciplinary field. **Methods:** The notion of “environment” is examined, a definition is proposed, and a look is taken at the “green” and “blue” sides of environmental problems. A number of understandings in various countries for “environmental health” are put forth and lists of basic areas for environmental health are analyzed. **Results:** One finding is that all lists are, in reality, unsystematic groupings of three different constituents: determinants, processes and functions. Consideration of these groupings leads to a homogeneous list of 18 areas and 77 sub-areas. Sets or series are provided for each type of constituent (64 determinants, 18 processes and 25 functions), and their aggregation forms the enormous universe of environmental health activities. On the other hand, certain rules of operation are proposed which make it possible, through a form of algebra, to construct expressions based on the provided sets of constituents. And it becomes possible to employ a common symbolic language for describing or assigning activities in the environmental health services. **Conclusions:** The article analyses the contemporaneous extent of environmental health.

## Keywords

EH: Environmental Health, EHS: Environmental Health Services, EHDet: Determinants, EHPro: Processes, Fct: Functions, EHSA: EHS’ Activity Matrix

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## 1. Terminology and Background

### 1.1. The Environment

Some definitions of “environment” follow:

“en-vi-ron-ment: *n.* 1: the circumstances, objects, or conditions by which one is surrounded 2 a: the complex of physical, chemical, and biotic factors (as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival b: the aggregate of social and cultural conditions that influence the life of an individual or community” [1].

“Environment: The sum of all external conditions affecting the life, development and survival of an organism” [2].

“In its broadest sense, the environment is a major determinant of human health and well-being [...] and unhealthy environments can create substantial morbidity, mortality, and disability [...]” [3].

The term “environment” has in English many (more or less) equivalent terms, like milieu, ambiance, ambient, setting, surroundings, medium, atmosphere and others. For our objectives, we will not use any of them but exclusively the word “environment”.

Thinking of planet Earth, the whole of all existing things and living beings (the aggregate of the planet’s ecosystems) could be called “physical environment”. When humans and their works are not taken into account, one usually talks on “natural environment”. It appears that the environment is generally viewed as an “object-centric”, and particularly an anthropocentric, concept or relative to something (live or inanimate). The following could be a general approach:

**“Environment, for each human being, human group, living or inanimate entity, at a chosen scale, is the whole of the surrounding physical world with its entities (living and/or inanimate and/or man-made) and their actions, interactions and interrelations.”**

People are immersed in the environment, and they can, for instance:

*to know* the environment’s generalities and details;

*to measure* environment’s parameters;

*to use/control* those circumstances of the environment which act on mankind’s life;

*to conserve/sustain* environment’s desirable, positive and pleasant characteristics.

### 1.2. Green and Blue Sides

Interactions as to *know*, to *measure*, to *use/control* and to *conserve/sustain*, bring about the need to manage and solve a multitude of **environmental problems**. In the second half of the XX century, it became conspicuous the appearance of two different views (even with colors attached) as to the management of environmental problems, particularly in the national and international public sector.

The *green side* is worried about what *people's activity can do to the natural environment* and includes aspects like sustainable development, biodiversity protection, climate change, ozone layer, poverty, demographic dynamics, land management, deforestation, desertification and drought, mountain areas, seas and coast protection, biotechnology, etc. The *blue side* (brown for some) is concerned about what *the environment can do to the health and welfare of people*; it has usually been called **environmental health**, and the discussion of its scope and structure is one of the main goals of this paper. The two sides or points of view are, of course, closely related, frequently embracing overlapping issues. Sometimes the separation or identification of scopes could be deemed difficult or artificial. However, such identification is important because, presently, there is a sort of institutional work distribution in the countries and at international level.

Nowadays the same “environmental health” designation or its equivalents is applied not only to an analytic set of knowledge and practices but also to a system of resources—human, physical, financial and institutional—dedicated to putting into action such knowledge and practices. Therefore, it is convenient to demarcate both aspects, and it could be as follows: call **environmental health**, or **EH**, to the analytic set, and **environmental health services**, or **EHS**, to the system of resources.

### 1.3. Environmental Health

A number of EH equivalent denominations exist, for instance: “environment hygiene”, “environmental sanitation”, “environment protection and development”, “health and environment”, “environment and health”, and others. In the public health domain, the name “environmental public health” is sometimes used. The term “environmental sanitation”, still employed in various countries, is prone to confusion because the current practice frequently reserves the word “sanitation” for wastes or excreta management. The term “environment protection and development” is wide enough to include EH, but by its very breadth, it could also embrace the entire “green” universe. The “health and environment” and “environment and health” names might receive as many meanings as many could be the interrogated persons or institutions. For some, “health and environment” signifies, literally, (human) health on the one side and environment on the other, in each case with whatever could be the arbitrarily designated range. The reverse may occur with “environment and health”. According to others, “health and environment” implies the influence of environment on health, but with an emphasis on health, and there is no lack of arguments to claim that “environment and health” points at an emphasis on environment. In summary, just “environmental health” is probably preferable.

### 1.4. Environmental Health Services

Within virtually every public governmental sector some kind of nationwide technical-administrative body exists, or more than one, with name, structure and in-

stitutional position largely varying from country to country, but anyway in charge to administer actions identifiably belonging to environmental health. Also, there exist, usually, local bodies (in regions or states or provinces or municipalities, etc.) among whose responsibilities are EH ones. As said above, we will apply to all of these bodies the uniform name of “Environmental Health Services” (EHS). Predictably, the name and affiliation of nationwide EHS throughout the world are diverse and we give some examples (Table 1).

In some cases, the EHS are not given all the political power or means to fully enable them to properly take care of the blue side of the environmental problems, and this is dangerous for public health. One significant aspect which is easily

**Table 1.** Name/affiliation of some environmental health services (EHS) (alphabetical order by country).

COUNTRY	EHS NAME	PARENT INSTITUTION
Argentina (a)	Department of Environmental Health	Ministry of Health and Social Action
Botswana (b)	Environmental Health Unit	Ministry of Health
Brazil (b)	Department of Policy and Environmental Evaluation	Ministry of Environment, Water Resources and Legal Amazonia
Chile (a)	Environmental Health Division	Ministry of Health
Colombia (a) (Atlantic Gov.)	Environment and Health Division	Atlantic Health Administrative Department
Costa Rica (a)	Directorate of Human Environment Protection	Ministry of Health
Dominican Republic (a)	General Directorate of Environmental Health	State Secretary for Public Health and Social Service
Egypt (b)	Department of Environmental Health	Ministry of Health and Population
Indonesia (b)	Directorate of Environmental Health	Ministry of Health
Ireland (e)	Department of the Environment and Local Government	Ministry for the Environment, Heritage and Local Government
Mexico (a)	General Directorate of Environmental Health	Secretary's Office of Health and Social Service
Morocco (f)	Department of the Environment	Ministry of Energy, Mines, Water and Environment
Panama (a)	Assistant General Directorate of Environmental Health	Ministry of Health
Peru (a)	General Directorate of Environmental Health	Ministry of Health
Philippines (b)	Environmental Health Service	Department of Health
Portugal (d)	Portugal Environmental Agency	Ministry of Environment and Territorial Arranging
Puerto Rico (a)	Auxiliary Secretary's Office for Environmental Health	Department of Health
United States (c)	Environmental Protection Agency	Federal Government

(a) After documents of the Regional Meeting on Institutional Development of the Ministries of Health's environmental health units. PAHO/WHO. San Juan, Puerto Rico, August 1998. (b) After documents of the WHO Interregional Meeting on the guidelines for the strengthening of environmental health services towards improved governmental action on environmental determinants of health. Geneva, Switzerland, May 1998.

(c) <https://www.epa.gov/aboutepa> (retrieved August 2010). (d) <https://apambiente.pt/index.php?ref=16> (retrieved August 2010).

(e) <https://www.gov.ie/en/help/departments/> (retrieved August 2010). (f) <https://www.environnement.gov.ma/fr/#> (retrieved August 2010).

neglected by local or national governments is the maintenance and conservation of physical installations or qualified human resources.

## 2. Environmental Health Definitions

A paper published by the National Institute of Environmental Health Sciences, NIEHS [4] advances that “A broad definition of environmental health encompasses not only the adverse effects associated with exposure to chemicals in air, food, and water but also the interaction of these exposures with genetic sensitivities and nutrition.”

The following was found in an overview of practice [5]: “Environmental health is a relatively new term, which has been used to define both a condition affecting human health and a professional discipline. Inevitably, it has come to mean different things for different people and different countries”. According to this same reference, the following definition was proposed at a World Health Organization, WHO, Consultative Meeting in Sofia, Bulgaria, 1993:

**“Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling and preventing those factors in the environment that can potentially affect adversely the health of present and future generations.”** See also reference Yassi, A. *et al.* [6].

## 3. The Multidisciplinary Field of Environmental Health

The EH field is so wide and complex that its research, theory and application need the involvement of many sciences, professions and technologies, for instance: sanitary engineering, medicine, public health, civil engineering, hydraulics, chemistry, physics, computing, microbiology, biology, epidemiology, toxicology, ergonomics, statistics, nutrition, genetics, toxico-genomics, molecular biology, proteomics, nanotechnology, economics, law, education, sociology, psychology, urban planning, business management, etc. In many cases, these professions evolve to new specializations, as environmental engineering, environmental medicine, environmental toxicology, environmental oncology, environmental education, environmental management, environmental health nursing, and even to new concepts, as environmental justice and environmental policy.

## 4. Recent History of the Scope of Environmental Health Problems

Below are given a few examples of the approach of international organizations and some countries on the subject of the EH extent.

### 4.1. Pan American Health Organization (PAHO/WHO)

The following broad categorization in areas was applied to EH towards the end of the 80's:

Water supply and sanitation;  
Solid wastes;  
Environmental risks for health;  
Workers health.

A document of 1994 [7] contains the following list of 22 program areas, which are said to “summarize all of the Sanitation Technicians activities, according to information gathered in the [American] Region’s countries”:

Drinking water;  
Excreta, wastewater and storm water;  
Solid wastes;  
Food hygiene;  
Improvement of housing and human settlements;  
Vector control;  
Zoonosis control;  
Public buildings sanitation;  
Sanitation of tourism and recreation places;  
Sanitation applied to sea, air and land transportation;  
Sanitation planning for urban and rural development;  
Workers health, hygiene and safety;  
Toxic materials control;  
Ionizing radiation;  
Accidents prevention;  
Environmental impact and health;  
Sanitary steps in special cases (natural and technological disasters, migrations, epidemics, etc.);  
Environmental pollution prevention and control;  
Prevention of water resources pollution;  
Prevention of flora, fauna and landscape pollution;  
General and management activities;  
Promotion of community involvement and sanitary and environmental education.

PAHO/WHO [8] used for EH in 1998 the designation “Environmental Protection and Development”. About technical cooperation, it listed the following items (as condensed by the author):

Community mobilization and inter-sectoral coordination;  
Education in environmental epidemiology and toxicology;  
Leadership and advisory role of ministries of health for environmental health planning and programming, and in developing local capabilities for the operation and maintenance of systems and services;  
Projects on the effects of environment on children’s health;  
Primary environmental care activities;  
Updating of standards and regulations governing the quality of environmen-

tal services and products;  
 Mechanisms to gather, analyze and utilize data and indicators on the quality of the environment;  
 Taking action in the countries on factors that adversely affect workers' health;  
 Water supply and sanitation to expand service coverage, improve the bacteriological quality of drinking water and intensify activities in rural areas and for indigenous populations;  
 Improving municipal solid waste management.

#### 4.2. World Health Organization (WHO)

When the United Nations Conference on Environment and Development (UNCED) convened in Rio de Janeiro, 1992, WHO presented the book *Our Planet, Our Health* [9] containing the main following chapters with a very thorough treatment of green and blue issues:

- 1) Health, environment, and development;
- 2) Global challenges to health and the environment;
- 3) Food and agriculture;
- 4) Water;
- 5) Energy;
- 6) Industry;
- 7) Human settlements and urbanization;
- 8) Transboundary and international problems.

#### 4.3. WHO/Europe Regional Office

Euro/WHO has the conceptual model **DPSEEA** (Driving Forces—Pressures—State—Exposure—Effects—Actions) [10] of health-environment interlinks to help design a system of EH indicators within the decision-making context. The **driving forces** component refers to the factors that motivate and push the environmental processes involved, and they generate **pressures** that often modify the **state** of the environment. This state creates an **exposure** that poses risks to human well-being only when people are present both at the place and at the time that the hazard occurs. Such exposure leads to a wide spectrum of health **effects**, acute or chronic. In face of the **environmental problems** and its health effects society attempts to adopt and implement a range of **actions**, for example, to reduce or control the hazards concerned, or preventive ones to eliminate or reduce the forces that drive the system.

#### 4.4. The Agenda 21

This document [11], also presented at the UNCED, devoted to the environmental health area (although not with this explicit name) seven out of 14 chapters of Section II, “Conservation and Management of Resources for Development”:

Protection of the atmosphere (Chapter 9);  
 Integrated approach to the planning and management of land resources

(Ch. 10);

Protection of the quality and supply of freshwater resources: application of integrated approaches to the development, management and use of water resources (Ch. 18);

Environmentally sound management of toxic chemicals, including prevention of illegal international traffic in toxic and dangerous products (Ch. 19);

Environmentally sound management of hazardous wastes, including prevention of illegal international traffic in hazardous wastes (Ch. 20);

Environmentally sound management of solid wastes and sewage-related issues (Ch. 21);

Safe and environmentally sound management of radioactive wastes (Ch. 22).

#### 4.5. Three International Organizations

Information was collected by the author (**Table 2**) in order to summarize what three organizations reported (c. 1993) as the scope of environmental health.

**Table 2.** The scope of environmental health, according to some international organizations (c. 1993).

PAHO/WHO	EURO/WHO	USAID/WASH
Water and sanitation	Water and sanitation	Water and sanitation
Solid wastes		Solid wastes
Control of environmental risks for health	World environment's troubles	
Workers health		Workers health
Housing hygiene	Urban environment's development	
Water quality	Water quality	
	Food innocuousness	Food hygiene
Environmental impact	Environmental impact	
	Outside air quality	Air pollution
	Inside air quality	
	Hazardous chemical materials	Hazardous materials
Hospital wastes	Hazardous wastes	
	Biotechnology	
	Urgent help	Wounds
	Less contaminant technologies	
		Wastewater
		Tropical diseases

PAHO/WHO = Pan American Health Organization/World Health Organization; EURO/WHO = WHO Regional Office for Europe; USAID/WASH = Water and Sanitation Program of the US Agency for International Development.

#### 4.6. Ireland

The Department of the Environment and Local Government [12] works mainly on EH issues as these:

- Atmosphere;
- Water;
- Eutrophication prevention;
- Waste management;
- Environmental Radiation;
- Noise;
- Environment Technology Action Plan;
- Chemicals;
- Genetically modified organisms;
- Agenda 21EU & International Unit;
- Sustainable development;
- Environmental liability;
- Emergency planning;
- Information on the environment;
- Environmental Assessment.

#### 4.7. Morocco

The Department of the Environment [13] is advancing a number of law projects in order to get a legal basis for the management of green and blue issues like these (condensed by the author):

- Atmospheric pollution;
- Accidental sea pollution;
- Wastes management and disposal;
- Environmental impact;
- Production/use of plastic bags;
- Coast protection;
- Surface water quality (incl. water for human consumption, irrigation and fish farming);
- Quality parameters for domestic and some industrial wastewaters.

#### 4.8. Portugal

The Portugal Environmental Agency [14] manages green and blue issues. It proposes, develops and monitors the implementation of environmental policies, particularly in (condensed by the author):

- Health and transportation sectors;
- Climatic change;
- Ozone layer;
- Air quality;
- Noise prevention and control;

Wastes management;  
Contaminated soil reclamation;  
Integrated pollution prevention and control;  
Serious industrial risks prevention;  
Environmental and population safety;  
Ecological labeling, ecological purchasing, voluntary systems for environmental management;  
Environmental impact assessment;  
Environmental liability;  
Risk management (technological, chemical, genetically modified organisms' risks);  
Alert network for radiological and nuclear risks;  
Environmental education;  
Protection of sea areas;  
Environmental regulations and permits.

#### **4.9. The United States**

The United States Environmental Protection Agency (EPA) [15] indicates that its mission is “to protect human health and the environment”. Also, it gives [16] the following alphabetical list of topics (which contains about 219 subtopics and a very large number of detail issues):

Air;  
Cleanup;  
Compliance & Enforcement;  
Economics;  
Ecosystems;  
Emergencies;  
Environmental Management;  
Environmental Protection Agency;  
Environmental Technology;  
Government;  
Human Health;  
Industry;  
International Cooperation;  
Pesticides;  
Pollutants;  
Toxics;  
Pollution Prevention;  
Radiation and Radioactivity;  
Research;  
Treatment & Control;  
Wastes;  
Water.

It is interesting to note that certain environmental concerns of the United States (see, below, examples of “green” and “blue” topics) go to federal administrations other than EPA, and also to tribal, state or local agencies [17]. EPA works cooperatively with many of these instances.

*Some “green” issues:*

Endangered Species Act is primarily managed by the U.S. Fish and Wildlife Service;

Wildlife and destruction of wetlands has much to do with the U.S. Army Corps of Engineers;

Situations of human development and wildlife such as foxes, birds, etc. are managed by state or local wildlife offices;

Information on gardening or farming is offered by the local Agricultural Extension office.

*Some “blue” (EH) issues:*

Environment inside the workplace is under the Occupational Safety and Health Administration (OSHA);

Safety of products used in daily life is the concern of the Consumer Product Safety;

Commission;

The Federal Insecticide, Fungicide and Rodenticide Act is managed cooperatively by EPA;

and the Food and Drug Administration(FDA);

Safety of food and any substance applied to human body is a concern of FDA;

Noise complaints are mainly regulated by local governments (e.g., cities’ and counties’);

Dust in roads is a local issue;

Issues about local landfill are for the county environmental agency.

## 5. Lists of Environmental Health Problems

Whenever EHS’s officials are organizing or modifying activities at institutional level, they will need to deal *inter alia* with the following fundamental aspect: What is the list of areas or issues (environmental health problems) to be managed? For some countries the list will be rather short in order to prioritize resources. Others would like to concentrate on the existing problems and postpone for later action what could arise from upcoming stages of development. Others may want to manage a very wide list with the aim of not leaving out any EH issue. It could happen that the national level EHS is concerned mainly with policies and regulations, while the local level EHSs perform the implementation, maintenance, etc. The author will now intend to offer assistance for the preparation of the list, and to that end a compilation and systematization of EH components will be proposed.

Through the examination of a number of documents as those mentioned above and others (e.g., Schaefer, M. [18]), a list can be built (18 areas and 77 sub-areas (Table 3)). Probably this list encompasses the vast majority of items one would need to include in the “environmental health” concept.

**Table 3.** Inhomogeneous list of areas and sub-areas for environmental health problems.

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- 1) Production and protection of safe drinking water
    - Surface water sources
    - Transportation and storage
    - Ground water
    - Water treatment
    - Disinfection (including in situ electrolytic methods)
    - Water distribution
    - Water quality (standards, control and surveillance)
    - Industrial water
    - Management and technology
    - Rate policies
  - 2) Sewerage and excreta disposal
    - Wastewater collection and transportation
    - On-site excreta disposal
    - Storm water collection and management
  - 3) Water resources and pollution
    - Management of basins and collection areas
    - Hydrogeology
    - Water bodies pollution (standards for discharge, control and surveillance)
    - Wastewater treatment
    - Wastewater disposal
    - Industrial effluents
    - Water conservation, recycling and reuse
    - Management and rates
  - 4) Solid wastes and soil protection
    - Standards
    - Household solid wastes collection and transportation
    - Household solid wastes treatment and disposal
    - Management of industrial solid wastes
    - Recycling, reduction, reuse and rejection
    - Soil pollution
  - 5) Air pollution
    - Standards
    - Monitoring
    - Emission controls
    - Transportation emissions management
    - Inside air pollution
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- 6) Food innocuousness
    - Food hygiene (standards for production, distribution, preparation, retailing, education)
    - Food-induced illnesses (absence of hygiene)
    - Pesticide use
    - Slaughterhouses control
  - 7) Workers health and safety
    - Occupational hazards and risks
    - Work place contaminants
    - Ergonomics
    - Industrial and agro-industrial safety
    - Standards and remedial measures
  - 8) Chemical safety and hazardous wastes
    - Management of hazardous chemical materials
    - Pesticides management
    - Hazardous wastes management
    - Hospital wastes management
    - Standards
  - 9) Human settlements and housing
    - Standards
    - Housing hygiene
    - Hygiene of public buildings and recreational areas
    - Repairing
    - Development
  - 10) Vector control and veterinary public health
    - Vector management in public health
    - Arthropods and rodents
    - Zoonosis control
  - 11) Ionizing and non-ionizing radiation
    - Standards
    - Management of radioactive wastes
    - Radioactive sources in health services
    - Industrial radioactive sources
    - Electromagnetic fields and health
  - 12) Noise pollution
    - Standards
    - Industrial noise
    - Transportation noise
    - Noise by other sources
  - 13) Tourism and environmental health
    - Beaches
    - Tourists lodging
-

**Continued**

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- Swimming pools
  - Health control in ports
  - 14) Urban planning and land use
    - Policies for urban and rural development
    - Environmental impact assessment
  - 15) Transportation safety
    - Accident prevention
  - 16) Drugs quality
    - Laboratories' bio-safety
  - 17) Global environmental aspects
    - Ozone layer depletion
    - Greenhouse effect
    - Energy and environment
    - Transboundary pollution
    - Environmental management
  - 18) Disasters
    - Prevention and mitigation of technologic and natural disasters
- 

**6. Determinants, Processes and Functions**

However, upon analysis of **Table 3** and of virtually any other list similar to the above-mentioned ones, the fact appear that they are all “inhomogeneous” because those environmental health problems contain an unsystematic assemblage of three conceptual categories or types the author calls *constituents*: Environmental Health determinants, for instance “water quality”, “household solid wastes” or “Vibrations”; Environmental Health processes, as “treatment”, control” or “education”; and functions, like “feasibility studies” or “promotion”. Suggested lists of constituents are mentioned further down.

***Determinants (EHDet)*** are the physical environmental *factors* or *facts* to be acted upon in order to satisfy EH-related human beings' needs. See in **Table 4** a list or series of 64 determinants, arbitrarily ordered and arranged in 20 groups. Criteria to identify a determinant: (a) It has to be described by a noun or by a nominal sentence, without adjectives; (b) It has to be of a reasonably detailed level. e.g.: Instead of “wastes”, put “solid wastes”, “wastewater”, etc.; (c) It will not mention processes or functions such as facilities, plants, etc. (e.g., “landfill”, “waste treatment”, “final design”).

***Processes (EHPro)*** are sets of *interventions*, in the frame of functions, applied to EHDet in order to define/solve an environmental health problem and an EHS activity. See in **Table 5** a series of 18 processes, operatively ordered.

***Functions (Fct)*** are sets of *management actions* applied to processes in order to have a full tool to be applied on determinants and so define an EHS activity. See in **Table 6** a series of 25 functions, according to an assumed operational order. Functions are not specific to environmental health because they enumerate

**Table 4.** The series of environmental health determinants (EHDet). This set comprises the first of the three constituents found to define an EHS activity. By taking action on determinants, which are real world factors, one or more problems related to environmental health get satisfied.

DETERMINANT AND SYMBOL			
DD01: Water for human consumption			
D01 Surface water	a) Rain water	b) Mist water	
D02 Ground water			
D03 Water quality			
DD02: Liquid wastes			
D04 Wastewater			
D05 Excreta			
D06 Storm water			
D07 Industrial effluents			
DD03: Water resources			
D08 Basins and collection areas			
D09 Pollution of aquatic bodies	a) Eutrophication	b) Invasive species	
DD04: Solid wastes and soil			
D10 Household solid wastes			
D11 Industrial solid wastes			
D12 Agro-industrial solid wastes			
D13 Soil pollution	a) Roads	b) Soil degradation	
DD05: Food products, water excepted			
D14 Foods	a) Producers	b) Manipulators	c) Factories
	d) Markets	e) Restaurants	f) Popular fairs
D15 Food induced diseases			
D16 Food's harmful biological agents			
D17 Other food's toxic agents			
DD06: Work environment			
D18 Workers environment	a) Informal sector		
D19 Workplace contamination			
DD07: Atmosphere			
D20 Vehicle emissions and immisions			
D21 Industrial emissions and immisions			
D22 Other contaminant emissions	a) Forest fires		
D23 Outside air contamination	a) Dust on roads		
D24 Inside air contamination	a) Smoking	b) Asthma triggers	
DD08: Human settlements and housing			
	a) Green buildings		
D25 Housing	a) Mold		
D26 Public buildings and recreational areas			

**Continued**


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D27 Other buildings and special establishments	a) Industry	b) Commerce	c) Education	d) Research	e) Cemeteries
DD09: Chemical products and hazardous wastes					
D28 Toxic and dangerous products	a) Endocrine disruptors				
D29 Pesticides					
D30 Hazardous waste	a) Batteries b) Fluorescent bulbs				
D31 Medical wastes					
DD10: Vectors					
D32 Insects and other disease transmitters					
D33 Zoonosis	a) Urban rodents	b) Bed bugs	c) Diptera		
DD11: Ionizing and non-ionizing radiations					
D34 Radioactive wastes					
D35 Health services' radioactive sources					
D36 Industrial radioactive sources					
D37 Low frequency electromagnetic fields					
D38 Other electromagnetic fields	a) Cell phones				
DD12: Noise and vibrations					
D39 Noise pollution of industrial origin					
D40 Noise pollution of transportation origin					
D41 Noise pollution from other sources					
D42 Vibrations					
DD13: Tourists and travelers					
D43 Beaches and other recreation sites					
D44 Hotels					
D45 Swimming pools					
D46 Ports					
DD14: Cities, territories and human groups					
D47 Urban milieu	a) Suburban sprawl	b) Events			
D48 Territory arrangement and natural world					
D49 Settings and their physical, psycho-social and ethical aspects					
a) Municipalities	b) Schools	c) Institutions			
d) Corporations	e) Scenery	f) Environmental related stress			
D50 Political, economic, financial and legal milieu					
a) International agreements and guidelines	b) ISO standards				
DD15: Vehicles					
D51 Traffic accidents					
D52 Transporters	a) Tourism boats				
DD16: Medical and household products					
D53 Drugs, cosmetics and other	a) Tobacco	b) Toys safety			
DD17: The planet					

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D54 Ozone layer	a) Ultraviolet radiation
D55 Greenhouse effect/climate change	
D56 Energy use	
D57 Transboundary contamination (particularly by sea or air)	
D58 Transboundary movement of hazardous materials or wastes	
D59 Deforestation	
DD18: Disasters	
D60 Anthropic disasters and emergencies	a) Terrorism
D61 Natural disasters and emergencies	
DD19: Other	
D62 Other determinants	a) Globalization
DD20: Environmental Health Services	
D63 Environmental health entities, in general	
D64 Water and sanitation entities	
DD99: DD01 to DD19	

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Note: In addition to the general and specific range of each determinant, a few particular instances of interest are annotated with small letter. These do not necessarily form new detail levels but rather constitute random items emerging from practice.

the steps for any projects' three typical phases (*i.e.*, **foresight, materialization, use**, all of that under a direction-function).

Please notice that each item in **Tables 4-6** has a code name (symbol) formed by the letters D, P or F (from Det, Pro and Fct) and a sequential number. Evidently, an adequate list of elemental activities could be generated, for instance, taking one determinant at a time and applying on it one or more adequate processes and functions, systematically. The lists' items could be endowed with additional levels of detail, assigning to them suitable sub-codes.

From the above it can be seen that the DPSEEA model (paragraph 4.3), when looked from the point of view of the three constituents, is also inhomogeneous. The “driving forces” are what we call determinants, along with the pressures, state, exposure and effects—all of them part of EH problems. And the “actions” are the processes and functions of the EHS.

## 7. The EHSA Matrix

Theoretically, the three constituent types could be viewed as the three dimensional arrangement {fct, pro, det}, subject to special operational rules and such that each triple coordinate defines an activity of the environmental health services. For the sake of simplicity, a graph is given of just a two-dimensional arrangement, the “Environmental Health Services' Activity Matrix”, or EHSA Matrix (**Figure 1**). Each cell would contain an activity to be undertaken by the services, originated by the intersection of rows (determinants) and columns (functions and processes). This way, **EHS Activities** are each elemental *combination*

**Table 5.** The series of environmental health processes (EHPro). This set comprises the second of the three constituents found to define an activity of environmental health services. Processes are interventions (guided by functions) on determinants.

Symbol	PROCESS	In addition to the general and specific range of each process, a few particular instances of interest are given below. These do not necessarily form new detail levels but rather constitute random items arisen from practice			
P01	Production	a) Intake	b) Collection	c) Sewerage	d) Pumping
P02	Transportation	a) Pipeline e) Pumping	b) Sewer	c) Canal	d) Main outlet sewer
P03	Treatment	a) Purification d) Reduction h) Landfill k) Electrostatic precipitation	b) Waste treatment e) Reuse i) Manipulation	c) Disinfection f) Recycling j) Catalysts l) Disinfestation	g) Reject
P04	Storage	a) Tank	b) Warehouse	c) Inventory	
P05	Distribution	a) House connections	b) Pumping	c) Marketing	
P06	Final destination	a) Elimination d) Dumping	b) Final disposal e) Drainage	c) Discharge	
P07	Improvement	a) P10 to P17	b) Development	c) Conservation	
P08	Safety	a) P10 to P17	b) Industrial safety		
P09	Hygiene	a) P10 to P17	b) Other processes		
P10	Control	a) Inspection	b) Sampling	c) Analysis	
P11	Surveillance	a) Inspection d) Epidemiological surveillance.	b) Sampling	c) Analysis	
P12	Consultancy	a) National/International cooperation			
P13	Information	a) Social communication networks			
P14	Education*	a) Curriculum modification	b) Environmental education		
P15	Social participation	a) Community participation (incl. NGO's and society at large)			
P16	Research	a) Community-linked research			
P17	Risk assessment	a) Environmental evaluation c) Exposure assessment	b) EHIA**		
P99	P01 to P17				

P01 to P09: "hardware"; relatively high investment. P10 to P17: "software"; relatively low investment. \*Formal, no formal, informal. \*\*Environmental health impact assessment. Apply (e.g.): EHProEHPro (of)(for)(on) EHDet.

stemming from a function acting on a process and on a determinant. Such activities have the ability to handle a specific environmental health problem and, therefore, are the EHS's *raison d'être*. Of course, each one of them must have a person in charge, an objective, a timeframe, resources and tasks. In practice, EHS will usually work with activity aggregates to be entrusted to persons or units.

## 8. The EHSA Algebra

*Operational rules for EHSA's.* This is a proposal intended to build a formalization mechanism leading to something like an algebra, which could allow the

**Table 6.** Function series (Fct). This set comprises the third of the three constituents found to define an activity of environmental health services. Functions are management actions on processes, thus on determinants.

Symbol	FUNCTION	In addition to the general and specific range of each function, a few particular instances of interest are given below. These do not necessarily form new detail levels but are random items arisen from practice
F01	Decision making and setting up of policies	a) Power acquisition by local levels    b) Special groups: children, natives, other c) Gender approach    d) Resolving responsibilities    e) Envir'tal policy
F02	Coordination	
F03	Preparation of legal instruments	a) Laws    b) Standards    c) Regulations
F04	Supervision	a) Quality control
F05	Planning	a) Indicators    b) Benchmarking
F06	Programming	
F07	Studies at large	a) Mathematical models    b) Geographic information/positioning system
F08	Analysis of appropriate technologies	a) Energy efficiency
F09	Feasibility studies	
F10	Final design	
F11	Financing	a) Resource mobilization    b) Rates
F12	Contracting	
F13	Implementation	a) Construction    b) Assembling c) Manufacturing    d) Production
F14	Start of operations	a) Enforcing
F15	Functioning	a) Operation    b) Maintenance
F16	Administration	a) Envir'tal management    b) Modernization c) Decentralization    d) Privatization e) Sustainability    f) Purchasing    g) Security
F17	Monitoring	a) Environmental public health tracking
F18	Assessment	a) Indicators    b) Audits c) Inspection    d) Comptrollership
F19	Human resources development	a) Training
F20	Promotion	a) Social communication
F21	Advocacy	
F22	Permit granting	a) Record keeping
F23	Certification	a) Accreditation
F24	Other functions	
F99	F01 a F24	

F01 to F04: Direction; F05 to F10: Foresight; F11 to F14: Materialization; F15 to F23: Use. Apply (e.g.): Fct for Fct; Fct for EHPro.

		Fct&EHPro (Functions; Environmental Health Processes)	
		F01 Pi, i = 1.. n	F02 Pi, i = 1.. n
			F03... ..
D01	.....		
D02	.....		
D03	<b>EHDet</b> (Environmental Health Determinants)		<b>EHSA</b> (EHS Activities) Fct>Pro>Det
D04	.....		
D05	.....		
D06	....		
D07	....		
....	....		

**Figure 1.** EHSA matrix (Environmental health services’ activities matrix). This matrix shows how an activity (each of the cells) is generated by the intersection of a column (functions and processes) and a row (determinants). As an example (not shown in the figure), the function “Feasibility studies” (F09) applied on the process “Treatment” (P03) give a column, and this column, intersected with the determinant “Wastewater” (D04), a row, originates an activity which could be phrased as “Feasibility studies for a wastewater treatment facility”.

usage of a mathematical system of symbols to denote constituent’s combinations. Rules are:

- The name of each EHSA results from the intersection of a row and column in the matrix. The conventional order in writing will be, from left to right: Fct, EHPro and EHDet.
- Symbol “greater than” (>) will denote the application of a constituent to another. This could, for instance, be interpreted as “for”, “of”, “on” or “about”.
- Constituent’s grouping will be denoted by the summation symbol (+). A large, same type constituents’ set can be simply indicated with “to” between the set’s ends. However, if more than one EHDet, they will be enumerated one by one, separated by commas.
- For the sake of brevity, the full Fct list will be denoted by F99 and the full Pro list will be denoted by P99. As to determinants, each area has a name (e.g., “Water resources” or “Tourists”). The full Det list (excluding DD20) will be denoted as DD99.
- The various constituents’ grouping levels will be indicated by parentheses ( ), square brackets [ ] and brackets { }, from inside to outside.

- It is permissible to apply one or more Fct over one or more Fct (e.g., F05 > F19) and also to apply one or more Pro over one or more Pro (e.g., P07 > P13).
- In the EH context virtually no combination without Det at the right hand side of the expression will make sense. However, it is possible to have combinations without Fct or Pro.
- Of course, not all possible combinations with Det make sense—for instance, P02 > D08 or (F12 > P06) > D32. (It can be estimated, in principle, the existence of some 14,000 possible [elemental] activities, which would form the EH universe).

**Table 7.** Some aggregates found in existent latin-american environmental health service units, and its equivalent in terms of determinants, processes and functions. (Descriptions given by the respective EHS were used to build the symbolic expressions, and the aggregate is the name of a unit; not all of the aggregates are necessarily examples to follow as good models. Notice that sometimes a clear relationship does not exist between the unit name and its *de facto* activity field).

AGGREGATE	SYMBOLIC EXPRESSION FOR THEDE FACTO ACTIVITY FIELD
Program for Drinking Water Quality Control	=P07 > D03
Program for Environmental Health and Sanitary Control and Surveillance	={{F22 > (P01 to P06)} + [P10 to P17]} > (D28, D29, D35)
Unit for Risk's Control in Food and Beverages	={{{F22 > (F13 + F15)} > (P01 to P06)}} > D14} + [(P10 to P17) > (DD05, DD13)]
Program for Basic Sanitation	=F20 > [(P11 > D03) + (P03 + P06) > D05]
Program for the Environment's Effects on Health	={{[(F06 + F13) > P16] + F03 + F07} > DD99
Unit for Environmental Sanitation	=(F99 > P99) > (D01, D02, D04, D05, D10, D23, DD10, D37)
Unit for Worker's Hygiene and Safety	=F99 > {{{(P08 + P09) > D18} + [(P03 + P07) > D19] + [(P07 + P08 + P09) > DD08] + [P99 > (DD11, DD12)] + [(P08 + P09) > D45]}
Program to Sanitize the Immediate Physical Environment	=[(P10 to P17) + P03] > (D32, D33)
Technical Unit	={{[(F03 + F23) > P99] + (P13 + P16)} > DD99
Unit for Control and Permitting	={{{F22 > (F13 + F15)} > (P01 to P06)} > (DD01, DD02, DD04, DD07, DD08, DD13)} + (F17 > F22) + [P11 > (D03, DD02, DD04, DD07, D29, D30, D31, DD12)]
Executive Direction for Basic Sanitation	=[(F01 to F14) > (P01 to P06)] > (D01, D02, D05, D10)
Unit for Risk's Analysis	={{[F99 > (P16 + P17)] > DD99} + {{{(F01 + F05 + F06) > (P01 to P16)} + P13} > D99
<b>SOME COMMON ENVIRONMENTAL HEALTH AGGREGATES AND ITS POSSIBLE EQUIVALENTS</b>	
Drinking water supply	={F99 > [(P01 to P05) + (P10 to P17)]} > (D01, D02)
Water and sanitation	=(F99 > P99) > (DD01, DD02, DD03)
Environmental audit	=[(F07 + F12 + F13 + F14 + F16 + F18) > (P01 to P10)] > [(DD01 to DD13), DD15, DD16]
Environmental Health Impact Assessment (EHIA)	=[(F07 + F08 + F09 + F18) > (P01 to P07)] > DD99

## 9. Aggregates

In practice, activities can be grouped (“aggregates”) in order to build the job theme to be assigned to a person or a unit within an EHS. Given an aggregate described by words, there exists a number of acceptable ways to “translate” that to the “EHSA algebra”, but a symbolic expression in said algebra has generally only one description in words, therefore being more precise. Translation examples worked over some Latin American cases are given (Table 7), as well as the symbolic equivalent of some usual aggregates.

## 10. Conclusions

1) The EH practitioner will find in this paper a probably useful panorama of his or her field as understood in a number of countries, and the theorist might find interesting the constituents approach. The EH extent examination revealed the necessity of some systematization, hence the suggestion to disassemble EH problems/activities so as to identify its three essential constituents (determinants, processes, functions) and to use a way (EHSA algebra) to reassemble them in order to define any activity.

2) The EHS persons and institutions could have, with the use of this conceptual tool, the means to objectively establish, allocate and assess the scope of their work and their particular position *vis-à-vis* related entities.

3) The EHSA algebra may work, in this context, as an operative means for intercommunication, teaching and research because it can provide a common symbolic language beyond idiomatic and cultural differences.

4) The author believes that the methodology of disassembling into determinants, processes and functions, and the reassembling as shown, could be useful not only for environmental health but also for other technical/scientific fields.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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