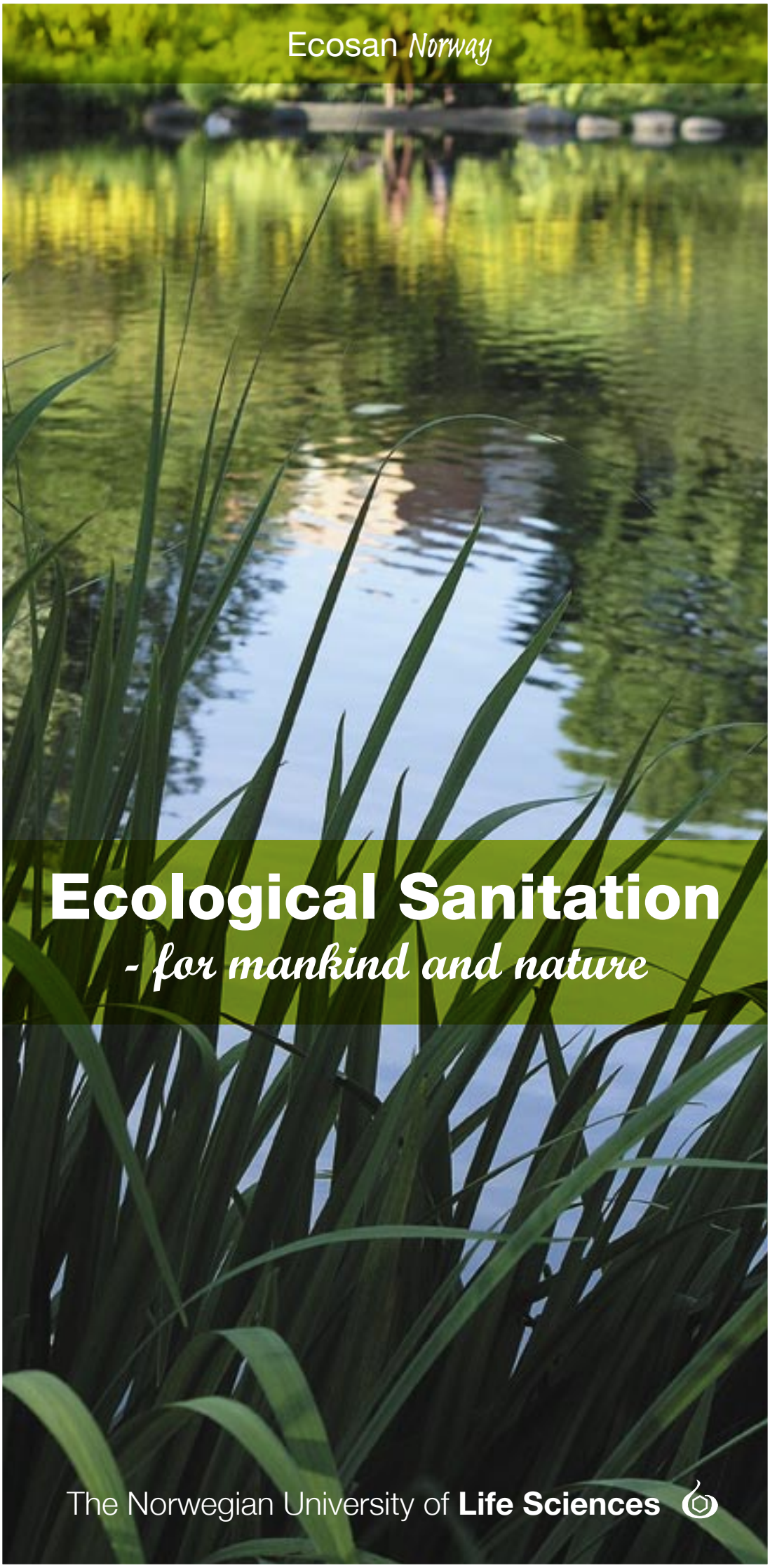
Ecosan *Norway*



Ecological Sanitation

- for mankind and nature

The Norwegian University of **Life Sciences**

Foreword

Last year the Norwegian University of Life Sciences (UMB) was commissioned to write a “Think piece” on Ecological sanitation by the Norwegian Ministry of Environment as part of the preparations for 12th Session of the UN Commission on Sustainable Development (CSD). This year the University of Life Sciences is supported by the Norwegian Ministry of Foreign Affairs to contribute to the 13th Session of the UN Commission on Sustainable Development in New York, with a focus on “water, sanitation and settlement”.

The Norwegian University of Life Sciences is in the forefront in the development of so called ecological sanitation in Norway. Ecological sanitation is part of ecological engineering that was defined by last year’s Stockholm Water Prize laureates professor W. J. Mitch and professor S. E. Jørgensen as: “Development of human society with nature for the benefit of both”. The essence of this sentence is sustainability and this is also the main philosophy guiding the activities at the Norwegian University of Life Sciences.

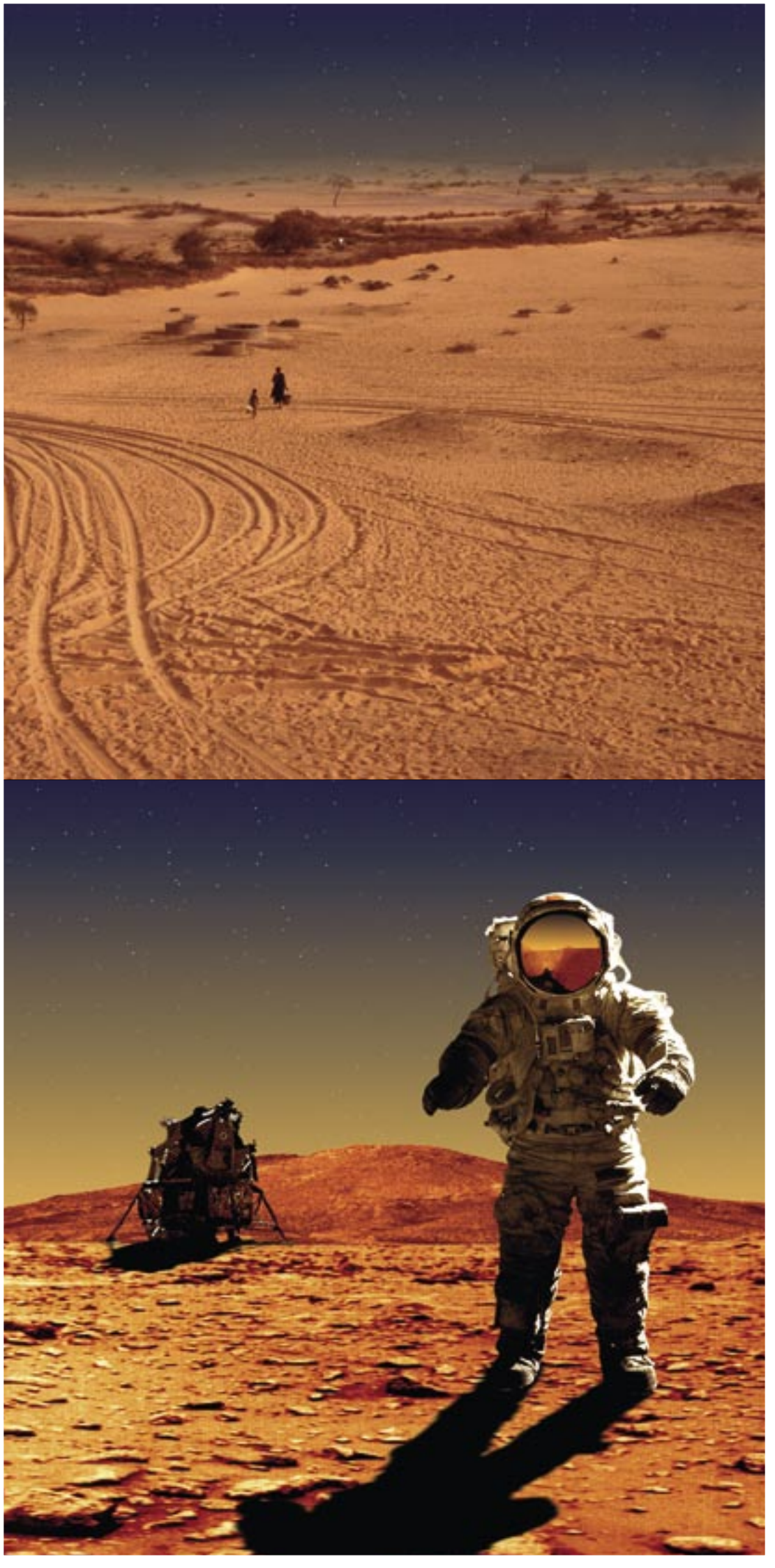
It is unlikely that one single system can solve all current and future sanitation needs. Large investments have been made in conventional centralized sewage systems that will be in operation for decades, but conventional systems will evolve as the principles of ecological engineering are communicated throughout the engineering society. Totally new systems, as well as hybrid or combination systems, will appear. With the present and growing focus on water and sanitation and their importance to human health and environmental quality, the interest in ecological engineering is rapidly growing. Universities, such as UMB, that teach ecological engineering and consultants and companies that implement ecological engineering will have advantages in the market because they can offer a broader range of solutions and more sustainable outcomes. A variety of systems are needed to meet the natural constraints of different geographic regions, differing regulations, different sociological aspects, different budgets, personal needs, and preferences.

The first part of this booklet focuses on sustainable sanitation and gives some examples of the vast field of ecological sanitation. The second part gives the possibilities for capacity building in sustainable water and sanitation solutions and a brief introduction to the Norwegian University of Life Sciences. A third and final part gives a few examples of technologies that are developed by companies that have research cooperation with the Norwegian University of Life Sciences.

The contents in the booklet is mainly based on text by professor Dr. Petter D. Jenssen, associate professors Dr. Petter H. Heyerdahl and Dr. John Morken, information adviser Knut Werner Alsén, all of the Norwegian University of Life Sciences, and Dr. Ken Gnanakan, who is heading the Indian NGO, ACTS, which is involved in developing sanitary solutions for the slum population of India.

The editors thank Deputy Director General Elin Bergithe Rognlie and Adviser Inger Næss of the Norwegian Ministry of Foreign Affairs for their support. We thank professor Dr. Robert L. Siegrist, of the Colorado School of Mines and associate professor Kjell Esser of the Norwegian University of Life Sciences for valuable comments.

Knut Werner Alsén
Petter D. Jenssen
Editors



Ecological Sanitation

- an option for all

Recycling is a natural process and inherently one that must be adhered to by living beings and societies that hope to survive. It has become a main principle in modern sustainable waste handling strategies. For example, in planning the first manned mission to planet Mars, NASA is relying on biology and advanced recycling solutions of water and plant nutrients.

The NASA expedition to Mars planned in year 2013 will include a crew of seven people. The journey will take 180 days one way and the astronauts will additionally spend 500 days on Mars before returning to Earth. In order to succeed on the mission, all water, oxygen and nutrients that are essential for the humans and their food production must be on board the space ship and there it has to be to be recycled. The astronauts will become vegetarians and advanced “eco-farmers” that use their own excreta in order to generate soil and nutrients for growing food. All wastewater will have to be treated and reused and new oxygen must be produced from carbon dioxide. A small biosphere will have to be created and moved to Mars and back.

For more that 20 years the scientists at the Norwegian University of Life Sciences have utilized the same principles as NASA is using for their Mars mission. The scientists have long known that the water and sanitary systems in rich countries are not sustainable and that waste-water and critical elements for plant production must be recycled.

Today new systems are being developed that give the equal or better comfort and health protection, reduce the water consumption by more than 50 percent and facilitate near complete recycling of plant nutrients for agricultural production. The systems can also produce soil amendment and energy from bio-resources. The total cost of the new systems is often lower, because of less need for large centralized sewers.

This new technology can be tailored to users in different economical and geographical settings such as the planet Mars, the Sahara Desert, New York, Nairobi, Oslo, the South Pole, or the slums of Bangalore India.

Ecological Sanitation

- for mankind and nature

Discharge of untreated domestic wastewater into the environment poses a major problem in many developing countries with high population densities. Besides eutrophication of precious water resources, untreated wastewater represents a hygienic problem, as its release into the environment with inadequate treatment involves spreading of pathogens, which is a serious threat to human health.

The Johannesburg summit on sustainable development set the goal of providing sanitation and clean water to at least half of those presently lacking it by the year 2015. However, if based on conventional water flushed sanitation systems, it is unlikely that this Millennium goal can be achieved.

This is because conventional systems involve large financial costs for construction and operation, consume energy and chemicals, have great management requirements, and a high demand for water. They also require educated and trained operators. Yet, effective wastewater treatment facilities are required to prevent negative impacts on public health and the environment.

The sustainability of conventional wastewater systems, commonly used in the developed world, can be questioned since they require large inputs of energy whilst at the same time clean water and nutrients are wasted. As populations grow and developing countries increase their standard of living, the environmental strain will increase further. The development of alternative, more sustainable wastewater technologies is therefore of paramount importance.

In the last decade or so, new sustainable, resource recycling sanitation systems, the so called ecological sanitation systems, have become available. Ecological sanitation can be based on source separation in which domestic waste is split into greywater (water from sinks, showers, and laundry machines) and blackwater (fecal matter and urine from toilets), facilitating recycling and providing more sustainable solutions for domestic waste and wastewater than conventional systems. Systems based on source separation transform waste into valuable resources, such as fertilisers and soil amendments. The recycled nutrients from such systems can help fill future demand for fertilisers in agriculture and agro-forestry.

From the slum in Bangalore, India.

Ecological Sanitation

- identity and dignity

The poor are the ones who suffer both because of their own “sins” and the “sins” of others. Not only do they face the pollution resulting from their own excreta, they often have to live beside water bodies that have been created by the discharge from urban sewers. Access to clean water and proper sanitation is a necessary precursor to development. Lack of clean water and adequate sanitation contribute to people remaining in the poverty trap.

Water and sanitation are major factors in the health status of populations. Conventional flush toilets have converted massive quantities of clean water into “blackwater”. In developing countries, 90 percent of sewage is flushed into surface waters polluting rivers, lakes and coastal areas. This has contributed to the spread of disease, mainly among the poor.

A basic issue in poverty is that of identity and dignity. The poor often lack identity as humans and therefore lose their dignity. Water and sanitation are factors that highlight this indignity even more. While the rich can be identified with their bottles of mineral water, the poor must be content with polluted water from any source, mostly contaminated by the rich. Most houses have no direct water supply. Women have to line up for a bucket full of water. Unsheltered defecation leave women exposed with a sense of shame. In India, poverty is also an issue of caste. The lower castes are confined to undignified jobs like handling the sewage of the rich; even drinking their wastewater. Transportation of “night-soil” is the job of the lowest caste condemned to such occupation.

Women’s participation in sanitation projects is important. This is mainly because women normally take on more social responsibilities than men. In many cases, men have tended not to be committed to such initiatives.

Efforts to improve water, health, sanitation, agricultural and nutritional should be integrated. Ecological sanitation propagates recycling principles in a very powerful way. The implementation of a material-flow-oriented recycling process as a holistic alternative to conventional solutions is the key to such practices. The poor, as well as the rich, will be able to observe the wider ecological issues as they focus attention on the basic water and sanitation problems.

Ecological Sanitation

- a zero emission concept

Many ecological sanitation systems are based on source separation so that waste can be transformed into valuable resources, such as fertilisers, soil amendments and bioenergy. Substantial amounts of plant nutrients and organic matter are present in waste and wastewaters from households and food processing establishments and industries.

Theoretically, the nutrients in domestic wastewater and organic waste are almost sufficient to fertilize crops needed to feed the world population. In addition, as much as 20-40 percent of the consumed water, is used for toilet flushing in sewered towns and cities. To move towards more sustainable systems a substantial portion of the nutrients must be recycled, the water consumption reduced, and the energy required by the wastewater treatment systems minimised.

Reduced blackwater volume

Modern vacuum or water saving toilets produce 5-7 litres of blackwater (toilet waste) per person and day, whereas conventional toilets normally produce 6 – 15 times more blackwater. This means that an average (Norwegian) family may reduce its volume to only 6 - 9 m^3 of blackwater per year, and 15 families may produce only about 10 m3 blackwater per month. Such volumes can be handled and treated locally and resources can be recycled.

From organic waste to fertilizer and energy

Even when the amount of flush water for a toilet is only 1 litre, the dry matter content would still be less than 1 percent. Due to this some organic matter must be added in order to achieve appropriate treatment of the blackwater by e.g. liquid composting. Grinded organic household waste, animal manure or residues from food processing are all additives that can be used to increase the dry matter content to a level required for successful composting. An efficient liquid composting unit is developed that leaves only hygienized and odourless effluents. By recovering heat generated by the composting process the unit run on a net positive energy budget.

Anaerobic processes are attractive because the methane (biogas) produced has higher energy quality than heath from a liquid composting process. Efforts are being made to develop anaerobic reactors on smaller scale for cold climates.

Suburban housing development, Torvetua Norway, vacuum toilets and local greywater treatment in a constructed wetland :

Processes for solidifying nutrient elements from liquid organic fertilizer sources also exist and facilitate future large-scale urban blackwater collection and fertilizer production.

Use in agriculture

A mobile ground injection system has been designed at UMB for the purpose of injecting liquid organic fertilizers directly into the ground. Characteristic of this equipment is that no plowing of the ground is necessary. However, the injection is made under high pressure in order to shoot the fertilizer into the ground. This creates an immediate contact with the soil that secures the absorption of ammonia and, thus, ensures improved accessibility of the nitrogen fertilizer.

Greywater

Greywater treatment can constitute an important aspect of ecological sanitation. Norway has developed its own set of sizing and design criteria for soil infiltration and sand filter systems that includes greywater. Biofilters and constructed wetlands using light-weight aggregates or similar porous media are pioneered in Norway have been successfully demonstrated. For greywater a light-weight aggregates biofilter and constructed wetland system can be made rather compact to facilitate urban applications.

In the city of Oslo (Klosterenga) the greywater from 33 apartments is treated to swimming water quality in the courtyard of the building. The space required for the total system is about 1 m^2/person, and the area is used as a playground.

Reuse of greywater

After treatment of the greywater in a biofilter followed by a constructed wetland, the effluent water can often be discharged to local streams, or be used for irrigation, or recharged to the groundwater. The excellent effluent quality also enables upgrading the water for in-house applications with modest use of technology and energy. If reuse is for flushing toilets and car washing it may be possible to use the treated greywater directly. To upgrade to drinking water quality or for washing, micro filtration, reverse osmosis or carbon filtration may be needed as a single step or in combination along with ultraviolet light or similar disinfection process. Reuse of all greywater makes water savings exceeding 90 percent possible when a water efficient toilet is used.

Health

In a source separating sanitary system blackwater is diverted from the water cycle, thus reducing the risk of contaminating surface and groundwater sources. With proper handling of the fecal matter, international research has shown that ecological sanitation may give an equal or higher reduction of pathogens than conventional systems and a high reduction in risk of exposure.

Conclusions

Experience from Norway shows that almost zero emission and complete recycling can be achieved by source separation and separate treatment of blackwater and greywater. Organic household waste can be treated jointly with the blackwater and, thus, increase the yield of fertiliser, soil amendment and bioenergy output. The treated blackwater can be injected directly into the ground and fertilise the soil with little or no odour. The water consumption can be practically reduced by more than 50 percent apparently without any reduced standard of living. Compact and technically simple solutions for greywater treatment facilitates decentralised treatment even in urban areas. This will further reduce the need for a secondary piping and pumping system for transporting untreated wastewater. The source separating systems reduce the risk of pathogens contaminating surface and groundwater.

Closingtheloop

Ecological sanitation (ecosan) is based on a sustainable, source separation system where domestic waste is split in a **Water Loop** (*greywater from sinks, showers, washing*) and a **Nutrient&Energy Loop** (*blackwater from toilets, supplied with organic kitchen waste*). Ecosan can reduce the water consumption by more than 50 percent and facilitate near complete recycling of plant nutrients for agricultural production. The systems can also produce soil amendment and energy from bio-resources. The total cost of the new systems is often lower, because of less need for large centralized sewers. The loops can be organized at household, community or city level.

TheWaterLoop

Resource from household

Treatment

Primary products

Refined products

TheNutrient&EnergyLoop

Resource from household

Treatments

Primary products

Refined products

Heat from arobic, biogas from anarobic treatment

DESIGN: Knut Werner Lindeberg Alsén

Norwegian University of **Life Sciences** www.ecosan.no

The Norwegian University of Life Sciences

Ecological Sanitation

- courses and education

Development of water and sanitation is largely a question of human development. But it is also a question of finding appropriate practical solutions. A key aspect of the work to meet the UN Millennium Development Goals for water and sanitation is the transfer of knowledge in areas where the need is greatest.

The Norwegian University of Life Sciences is one of few universities worldwide offering MSc programmes including ecological sanitation. The curriculum at the Norwegian University of Life Sciences provides undergraduate, graduate and post-graduate opportunities involving water and sanitation. All water-related programs focus on sustainability. For Norwegian-speaking students a 5-year civil engineering program in water and environment is offered. For English-speaking students, several options exist:

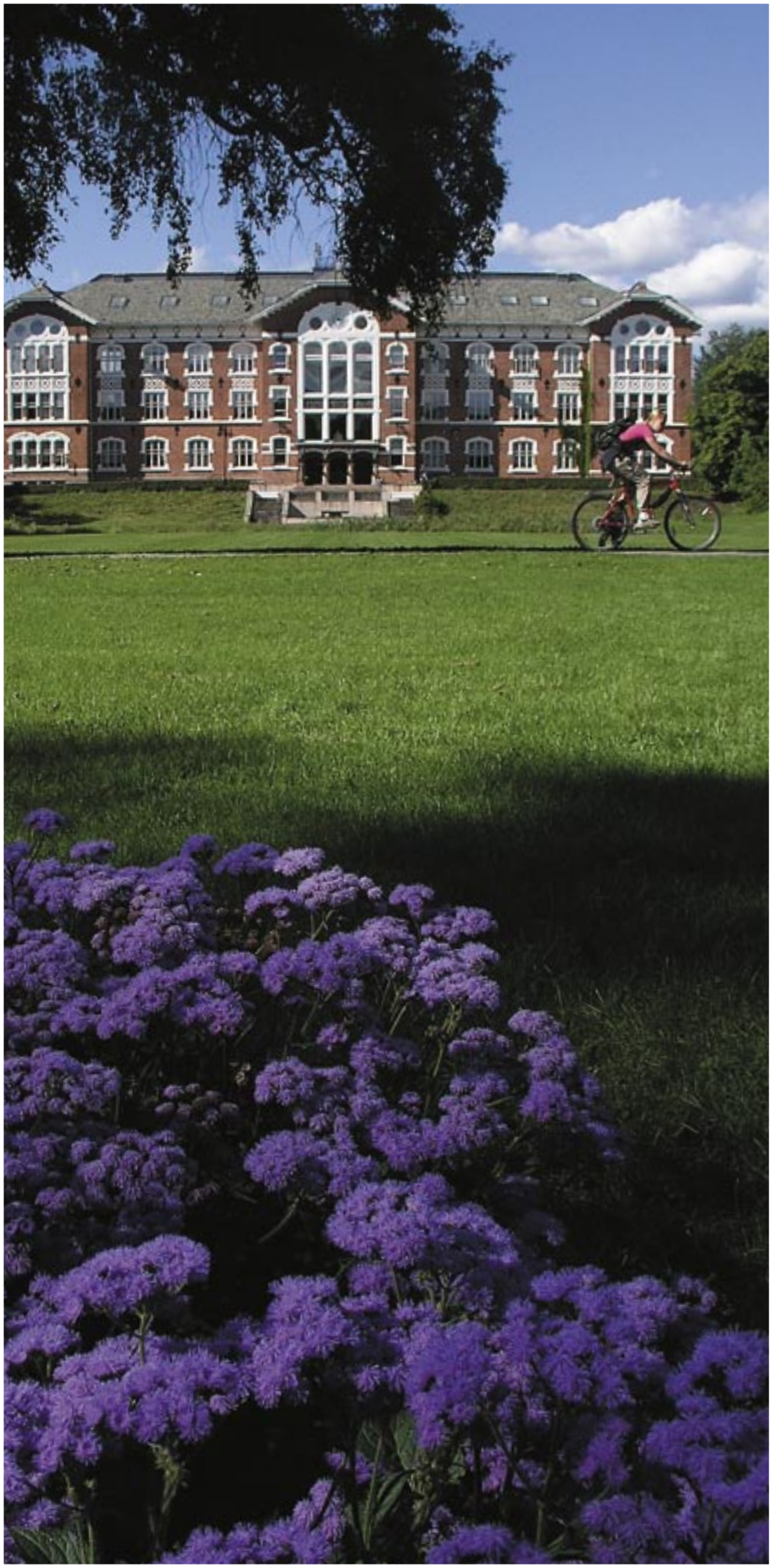
MSc Development Studies
This master with specialisation in environmental technology and management meets the demand for competence arising from the Millennium goals for water and sanitation. The program gives a broad introduction to sanitation engineering, water and waste management. In the engineering part, emphasis is placed on the ecological engineering approach. The program also deals with the institutional and social settings, constraints and potentials of waste treatment systems, risk assessment and the effects on sustainability and economy.

Short Course in Appropriate sanitation
The focus of this course is to explore ecological sanitation solutions for developing countries. Solutions for crisis situations are also discussed. The course is designed for both professionals and students. Participants include consulting engineers, NGO-personnel (field and administrative), public officials (e.g. health and foreign service), research scientists, and students from various disciplines. Duration is one week.

MSc Natural Resource Management and Sustainable Agriculture
In this program the students explore the complex relationship between sustainability and the environment focusing on the importance of natural resource management as a means of poverty reduction and sustainable development in rural areas.

MSc Agroecology
The programme prepares students for a wide range of positions related to conventional and organic agriculture, e.g., within the advisory service, development projects, industry sales and technical support, management of agricultural and natural resources, environmental protection, and education.

Studies in Norway are tuition free. The students must, however, document that they can cover running expenses (accommodation, food, study material) amounting to approximately 900 Euro pr month. Read more: www.ecosan.no



Norwegian University of Life Sciences

The Norwegian University of Life Sciences (UMB) is recognised as a leading international centre of knowledge, focusing on higher education and research in environment and biosciences. The University's main specialisation areas are biology, food, environment, land use, and natural resource management.

In addition, there is a substantial focus on applied science and engineering. The Norwegian University of Life Sciences provides research services to both the private and the public sectors.

The Norwegian University of Life Sciences is a centre for national and international environmental research, focusing on the sustainable use and management of terrestrial and aquatic resources, including the use of the natural environment for increased human and animal welfare. The centre organises interdisciplinary research groups within the fields of natural science, social science and engineering. Environmental research at the Norwegian University of Life Sciences is of high international standing, and is based on extensive national and international networks.

A wide range of basic and applied research generates expertise, which constitutes an important basis for education at UMB. Environmental research at UMB is divided into three programme areas:

- Environment and Bioproduction: This programme studies the environmental impact of agriculture, forestry and aquaculture. Ecological engineering is a part of this programme area.
- Environment, Landscape and Climate: This programme studies the impact of environmental changes and pollutants on terrestrial and aquatic resources.
- Environment and Improved Welfare: This programme focuses on our natural environment and how it affects human and animal welfare. It also studies measures aimed at increasing human welfare and how people experience different environments.

The Norwegian University of Life Sciences consists of 8 departments and offers 13 bachelors and 37 masters degrees within the following fields: environmental science, land-use planning, land tenure, plant science, animal science, aquaculture, mapping sciences, landscape architecture, nature management, natural sciences, biotechnology, food science, forestry, engineering, resource economics and natural resource management.

Postgraduate studies are offered, and the doctorate degrees PhD. and Dr.Philos. are awarded.
Read more: www.umb.no/studies

Industrial innovation and development

The Norwegian University of Life Sciences works closely on issues related to industrial innovation and development and commercialisation of research results. We are proud to present some Norwegian technologies of importance for the ecological sanitation concept. *

The examples that follow represent a small selection of industries that cooperate with the university.

* Presentation of companies or products does not constitute endorsement by The Norwegian University of Life Sciences.

Vacuum toilets

- a shift of paradigm

One key component of source separating recycling sanitation system is the water saving vacuum toilet that facilitates concentrated collection of toilet waste (blackwater) and subsequent processing of the blackwater into fertilizer for agri- and silviculture. This technology which diverts toilet waste from the water cycle, thus protecting potential potable water sources, are becoming increasingly popular as a means to avoid increased water costs.

Vacuum-toilet technology developed for marine installations is dominating the marine market today. Modern cruise vessels can have more than 1600 toilets and 2-3 km of vacuum piping. Despite the low water consumption, equal or higher sanitation standard than the traditional WC is achieved. Vacuum-toilet systems are available for, apartments, single homes and cottages, tourist resorts, and preferred by hospitals in India and France.

Several companies manufacture vacuum toilet systems. The technology differs slightly between the manufacturers. The Norwegian company Jets Standard A/S use a unique and robust vacuumaerator. Vacuum is generated on the toilet side. The aerator macerates the blackwater and provides pressure on the discharge side. This facilitates transport to a collection tank or existing sewer even if the aerator is located below the tank and sewer. The macerated effluent reduces risk of clogging of pipes and allows small diameter (20 mm) discharge pipes.

The energy consumption is about 4kWh pr person and year, according to the manufacturer, and the smaller units are available in a solar powered version.

Vacuum toilets are easy to retrofit in existing buildings - without disturbing any functions of the building. The small diameter pipes and the vertical lift capacity ensure a flexible system that reduces installation work. Installation costs for vacuum toilets are therefore normally lower than traditional WC´s.

The water saving vacuum toilet systems are often preferred in areas where the water and energy costs are high, as in dry and densely populated areas of Brazil, India and the Mediterranean. In Europe, vacuum toilets are becoming increasingly popular because of increased water cost and thus short payback time.

Water treatment

- purifying for households

There is a growing market demand for chemical free water processing. Membrane filtration offers new possibilities for production of drinking water without leaving treatment chemical residues in the processed water.

The potable water can be made from a variety of sources including treated greywater. A challenge is often to find a cost efficient treatment option prior to the membrane filtration.

Natural systems and biological methods are interesting options where the Norwegian University of Life Sciences deliver competence. In Norway solutions that do not add any undesirable extraneous matter to the drinking water during the treatment process is produced by the company Fluidtec® a member of the Goodtech ASA group.

The company's drinking and clean water production is generally based on membrane filtration technology, combined with ultra-violet irradiation.

The company also deliver small and medium size biological wastewater-treatment plants (Biovac®), well suited in a decentralized treatment concept. The company's customers include waterworks in Norway and abroad.

Greywater treatment

- in constructed wetlands

In Norway systems consisting of an aerobic biofilter followed by a subsurface horizontal flow constructed wetland have been very successful for treatment of traditional wastewater (toilet waste and greywater) and greywater only. This is due to performance even during winter and low maintenance. Today this system is rapidly becoming a popular method for wastewater treatment in rural Norway. The systems can be constructed regardless of site conditions.

The design is standardised using specially made lightweight aggregate (Filtralite®), but the system can also be designed using local sand or gravel, or other porous media.

The high phosphorus removal, expected to last 10-15 years is achieved using a new manufactured lightweight aggregate (FiltraliteP®) with P-sorption capacities, which exceeds most natural media. When the media is saturated with phosphorus, it can be used as soil amendment and phosphorus fertilizer.

For greywater only the total area of the combined biofilter/constructed wetland is 1-2 m^2/ person and the effluent meets European swimming water standards with respect to indicator bacteria and WHO drinking water standards with respect to nitrogen. The low area requirement of the system and the high effluent quality facilitates use in urban settings, discharge to small streams or open waterways and subsequent treatment producing water for in house use.

Urban greywater treatment in a constructed wetland, Klosterenga, Oslo, Norway.

Liquid composting

- for recycling organic wastes

The liquid composting process was developed to hygienise and deodorize animal manure. The main market of this system turned out to be treatment of blackwater together with organic household waste and animal manure or waste from food processing industry.

The treated material is stored, prior to spreading on farmland during the growing season. The wastes are converted into a hygienic, stable and odour-free liquid product. No nutrients, including ammonia, are lost during transport, processing and storing. The product is suitable for fertilizing cereals and grass.

The liquid composting unit that operates with less than one percent nitrogen loss has been developed at the Norwegian University of Life Sciences and is now marketed by the company Biocontrol A/S in Norway.

The majority of the liquid composting units are farmer operated. In a small municipality not far from the university, a farmer collects all source separated organic household waste as well as septic tank sludge and empties holding tanks for blackwater. This is mixed with animal manure and liquid composted to yield fertilizer which is used on site.

The material is sanitized and stabilized in a thermopile aerobic reactor at a temperature of 55 – 60 degrees C, thus effectively reducing pathogen content.

The reactor can process, semi-continuously, a wide range of liquid wastes with dry matter content from 2 to 10 percent. The hydraulic retention time is 5 - 7 days. A control system runs the process based on given set values to ensure the product quality. The process is characterised by high oxygen utilization, low air flow, no ammonia loss and no odour release.

The degradation of organic matter is moderate, and the processed substrate has approximately the same agronomic value as the original substrate. When supplied with air, the aerobic bacteria break down the organic matter into simpler compounds. This process releases considerable amounts of heat which raises the temperature of the substrate. No energy is added for heating the biomass. The thermopile aerobic reactor therefore requires no additional energy except for that needed to run the technical equipment.

The Direct Ground Injection System

The main source of ammonia losses to air is wastes, and more than 50 percent of the losses arise from the spreading of manure or organic fertilizer slurry. Since spreading of liquid waste is a main source of emission, an important area for reductions of emission is improvements of slurry spreading technology.

The Direct Ground Injection (DGI) shows a reduction of ammonia emissions of more than 70 percent as compared with traditional methods. Energy use is reduced with approximately 50 percent as compared with other mechanical injectors.

The yields using DGI and liquid organic fertilizer are comparable to yields with mineral fertilizer.

The Direct Ground Injection (DGI) concept has been developed at the Norwegian University of Life Sciences in cooperation with industry and is now marketed by the Norwegian company Moi A/S. DGI involves a pump to pressurize the slurry (5-10 bars), which is then distributed to nozzles along a boom. There is no device that enters into the soil because the slurry itself is doing the job of injection. The nozzles are located in skis or shoes that slide on top of the soil.

The depth to which slurry is injected can be manipulated by altering the working pressure of the DGI.

Five nozzles are located on each boom. There may be 2 or 4 booms on a spreader, and the working widths will then be 3 or 6 m (10 or 20 nozzles).

The Direct Ground Injection has several advantages. It is easy to use in hilly terrain, there is a significant reduction in ammonia losses and in malodours. DGI gives low maintenance costs and energy consumption. Seeds can be mixed and injected with the fertilizer thus saving one operation.

The energy step:
Biogas production

Anaerobic digestion that yields biogas provides an excellent method for treatment of a variety of organic waste. In hot climates biogas can be produced in simple facilities e.g. at farm level. Such facilities can be constructed using local materials and knowledge or simply by using a polyethylene bag with water locks.

Trials at the Norwegian University of Life Sciences show that blackwater from vacuum toilets mixed with grinded organic household waste is well suited for anaerobic digestion.

In Sarawak, Malaysia a large biogas facility with capacity to treat sewage sludge and blackwater from the city of Kuching (400 000 persons) is planned with Danish assistance. This biogas facility will have capacity to treat blackwater from the city as the city develops ecological sanitation based on low flush toilets and blackwater collection.

Ecological sanitation is now successfully tried in a pilot project involving the Norwegian University of Life Sciences and the current plan is to upgrade the majority of the city to ecological sanitation because it is cheaper than conventional sanitation and has more environmental benefits.

Construction of an anaerobic treatment facility will greatly reduce the need for landfill area in Kuching as the waste is turned into fertilizer for palm oil production and bioenergy.

Commercialization of systems for anaerobic digestion is mainly going on in other countries than Norway. However, one company, BioTek AS, that cooperates closely with Denmark is Norwegian based.

The Norwegian University of Life Sciences has extensive knowledge in the field of anaerobic digestion and plan to develop a small scale anaerobic reactor for cold climates.

Decentralized and ecological sanitation concepts

Norway is at the forefront of developing environmentally safe solutions to water, wastewater and organic waste treatment. By combining new and existing technologies, sustainable concepts that provide clean water, save water and reclaim and recycle waste resources can be realized.

The Ecomotive Group of Norway is a new industry consortium that is conceived to specialize in the design of sustainable water and sanitation systems based on resource recycling and provides a diversity of options for both rich and poor countries, from household level up to systems for mega-cities.

The solutions are flexible and can be tailored to high-tech environments as cruise-ships and modern Scandinavian housing developments as well as decentralised solutions for cities in Asia, Africa and Latin-America. The systems are decentralised thus reducing the need for pipelines, the most expensive part of a traditional sewer network.

The Ecomotive Group of Norway cooperates with leading Norwegian Research Institutions, in particular the Norwegian University of Life Sciences.

Read more: www.ecomotive.no

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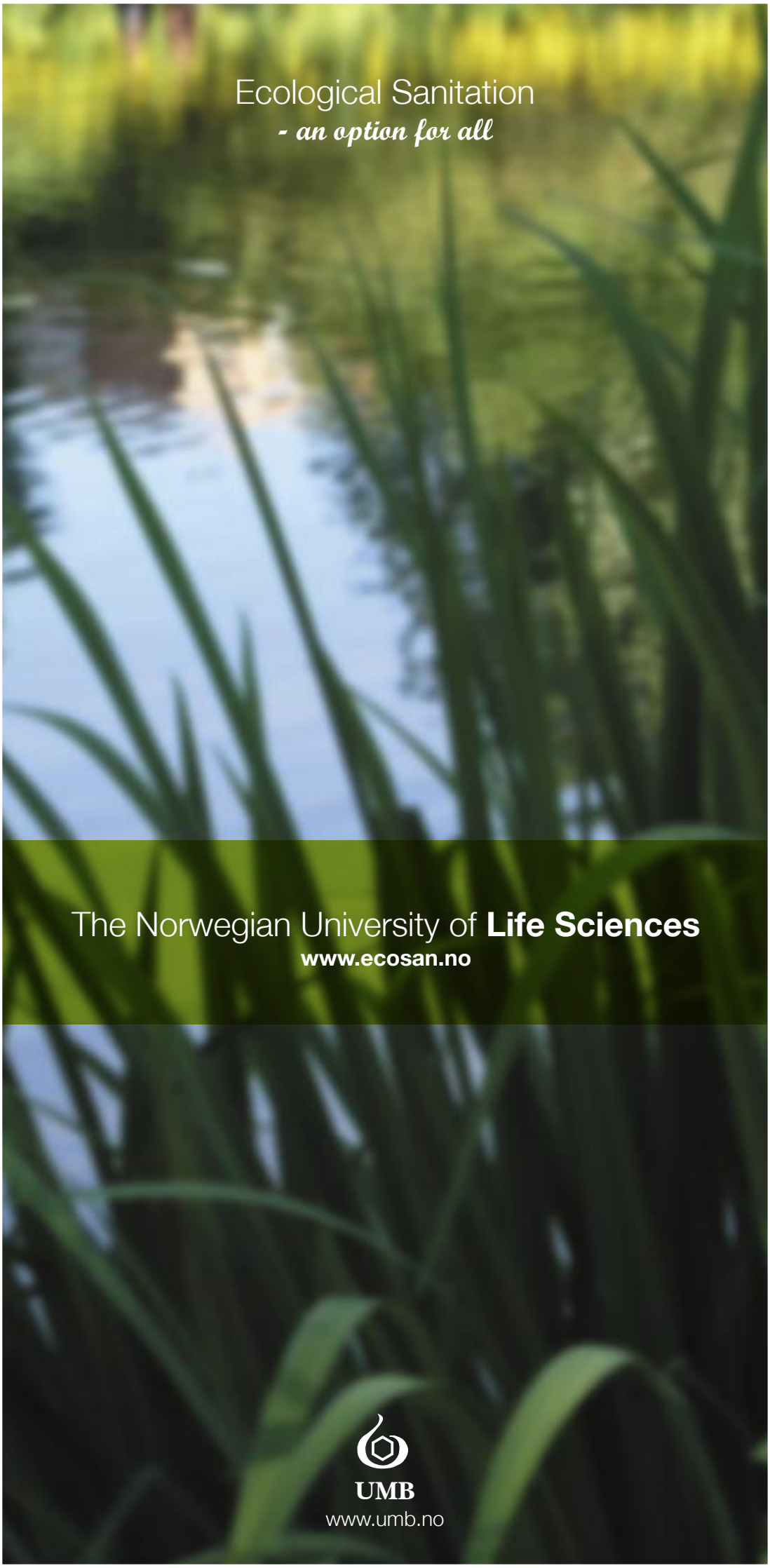
Photo: Johannes Heeb, Petter Jenssen,Knut Werner Alsén, Moi AS, Goodtech, Luth & Co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