The potency of local 'waste' water treatment in rural areas (summary)

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April 2011

secondary school final project

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Emerging resistance

Through history the Dutch have been renowned for their knowledge of water management. Every Dutchman is supplied of high quality drinking water, all their waste water gets an extensive treatment and surface water is fully suited to bathe in.

The policies of wastewater treatment of the past decades have been characterized by increasingly improved quality of effluent and treatment processes. Today, effluent form Dutch wastewater treatment plants (WWTP) naturally complies with European standards; it's even cleaner.

This trend has been paralleled by the scale-up of WWTPs in order to obtain the lowest treatment costs per treated unit. The WWTP's are highly automated and require little staff.

The scale-up has resulted in a huge network of sewers. 99% of the Dutch population is connected to its network and others have an individual sewage disposal system. To put this in perspective, only 82% of Frances population is treated and only 76% of Portugal's population. (Wikipedia)

The central managed wastewater treatment with its huge network of sewers was implemented in a time in which its functioning was relatively cheap. Most of the sewers were built after the second world war, after which labour and economic activity had to be encouraged. Energy was cheap, raw materials and chemicals were abound and the economy was prior to ecology.

Today, however, wastewater treatment finds itself in a completely different situation. It is facing a lot of difficulties. The network of sewers requires more and more money for energy prices are rising with the speed of light and renovation costs are becoming increasingly higher. An increasing number of sewers will have to be renovated over time for the technical lifespan of a gradually increasing number of sewers comes to an ending. In addition, storm water increasingly pours in ebbs and flows resulting in a higher need for capacity of sewers and also for WWTP's.

Apart from the network, in general we are facing a time of raw material exhaustion and climate change. Emission of greenhouse gasses will lead to higher costs by means of investment in emission rights. Higher standards to which treatment must comply are demanded by the European union. More and more money is spend on sludge treatment and technologic advances are hard to implement. Due to scale-up of waste water treatment plants new components are hard to get in compatible with the existing components.

The rising costs are and will not be left unnoticed by the common man and taxpayer. In thirty years, the exploitation costs of waste water treatment has almost tripled.(CBS, 2006). If the current trend pursues it won't take long before the taxpayer doesn't accept it any longer. In addition the pressure of environmental activists and instances will raise. Waste water treatment policies need and will be forced to focus on repelling the trend in an ecological way.

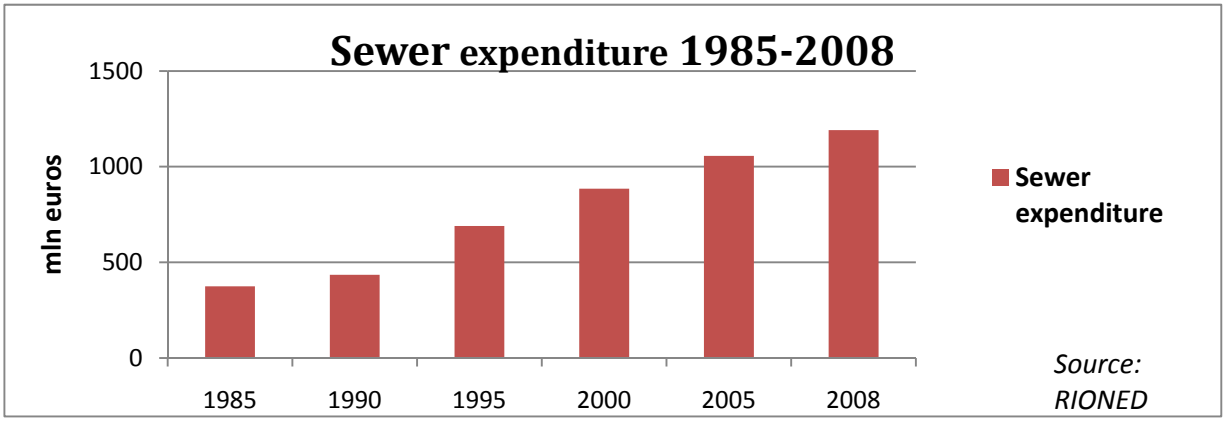
Drastic change in policy

Two types of strategies are subjects to research; decentralisation and the WWTP as a manufacture of energy, nutrients, minerals and pure water.

Decentralisation

To fight the increasing drawbacks of centralised wastewater treatment an increasing number of people put forward a strategy of decentralising. Decentralised wastewater systems treat wastewater close to the source, typically using small pipes for collecting small volumes of domestic wastewater. This is of particular interest in rural areas where wastewater has to be transported over long distances. As a result treatment costs are highly determined by energy costs and maintenance and capital costs are far higher than in urban areas.

By treating the water locally almost all transportation costs can be eliminated. The highly increasing sanitation costs can be converted in a decreasing trend.



A low-scale local treatment system can be designed to meet future current standards and can also be adapted to newly developed technologies in order to be more cost-efficient more easily.

They might be even financial profitable in stead of a cost factor. Decentralisation in rural areas namely offers more opportunities than being cost-efficient alone. Flows which are not used today and are hard to use when treatment is central regulated can be utilized in local treatment. This includes heat and rainwater.

Local wastewater treatment could substitute central wastewater treatment in prosper countries such as the Netherlands, but could also be the solution for countries where wastewater treatment isn't seriously done yet. Central wastewater treatment only functions when a vast network of sewers and pipes and a large-scale WWTP is constructed. This however is not feasible in developing countries or in poor areas, for the investment is huge. A decentralised system has a far lower investment level and is therefore much easier to apply.

Ecological manufacture

Our behaviour must change to make the world sustainable, to turn the world into a place where our grandchildren can live happily too. There's an urgent need to deal with materials parsimoniously and sustainably. This is translated into the concept of cradle to cradle, which gets an increasing attention. This concept hasn't been introduced in wastewater treatment yet. Current wastewater treatment focuses on the removal of toxic and polluting elements when released in surface waters. However, this 'waste' is not to be removed but to be recovered. Wastewater contains valuable and rare materials. Heavy metals, such as copper are so much more rare than oil and are being wasted in today's policy. Nutrients, and in particular phosphorus, are getting rare and are indispensable for every living organism including humans while treatment management is working its legs off for the removal of these nutrients. Of the 14,9 million tons of phosphate ore mined worldwide, 3,5 million tons find its way in wastewater and vanish in the treatment processes. Besides, fresh water recourses are getting scarce. Especially when a climate change appears. We need to transform our waste into raw materials in compliance with the cradle to cradle concept.

Likewise expensive energy is to be generated instead of consumed. A waste water treatment facility should be a supplier of energy. Even in the way treatment is managed now, wastewater contains in potency eight times the amount of energy than is required for treatment(STOWA, 2010-11)

The biomass and heat of wastewater are seldom used as source of energy. Meanwhile, some of the bigger WWTP's have installed digesters to convert biomass to biogas, but surplus heat of CHP's in which the biogas is burned is rarely used. In addition the heat of today's wastewater, which is added in the household, flows into the sewerage network and all heat is lost in no time.

The manufacture strategy envisions wastewater as a source for energy, nutrients, water and minerals. And this in an ecologic concept.

The use of chemicals must be avoided in order to deal with elements economically, unless these chemicals are originating in nature or are biodegradable. Natural occurring treatment processes are to be simulated and stimulated optimally, because they are harmless to the environment. An additional advantage is that natural occurring processes are cheap.

To fight global warming greenhouse-gasses are to be reduced drastically. This is inextricably linked to the use of fossil fuels. Reducing the energy consumption and increasing energy production can make the treatment facility greenhouse-gas neutral. even More can be attained by stimulating photosynthesis.

For all these aims solutions still must be found. Below I describe a concept in which all aims could possibly be achieved.

Decentralised ecological manufacture

In both strategies a part of the approaching problems for wastewater treatment is solved. In case both strategies are combined all problems would be tackled for those strategies are actually complementary. It already proved to be so. In a district in Sneek for example 32 households are connected to a treatment facility according to a concept called DESAR. This system turned out to be very effective in recovering raw materials and is energy-efficient. It still doesn't compete with conventional treatment regarding costs, but it is still subject to research and it is of course a first step toward a decentralised ecological manufacture. Besides this project it isn't functioning in a low density rural area.

The concept DESAR is based on new construction (collecting wastewater flows separately) while the population isn't growing much and it can't substitute today's network. Renovation would deeply reach into houses and buildings and that would simply be too expensive.

For existing construction you have to set off on a different tack. Black water and grey water arrive at the treatment facility combined and has to be separated. The concept I developed is based on existing construction.

My inspiration was bioremediation, the use of microorganism metabolism to remove pollutants. The self-recovering, self-cleaning ability of nature is huge, regard for instance the latest oil-spill in the Mexican golf. A huge disaster for nature but everything seems to be cleaned. This natural ability is formed by bacteria and algae.

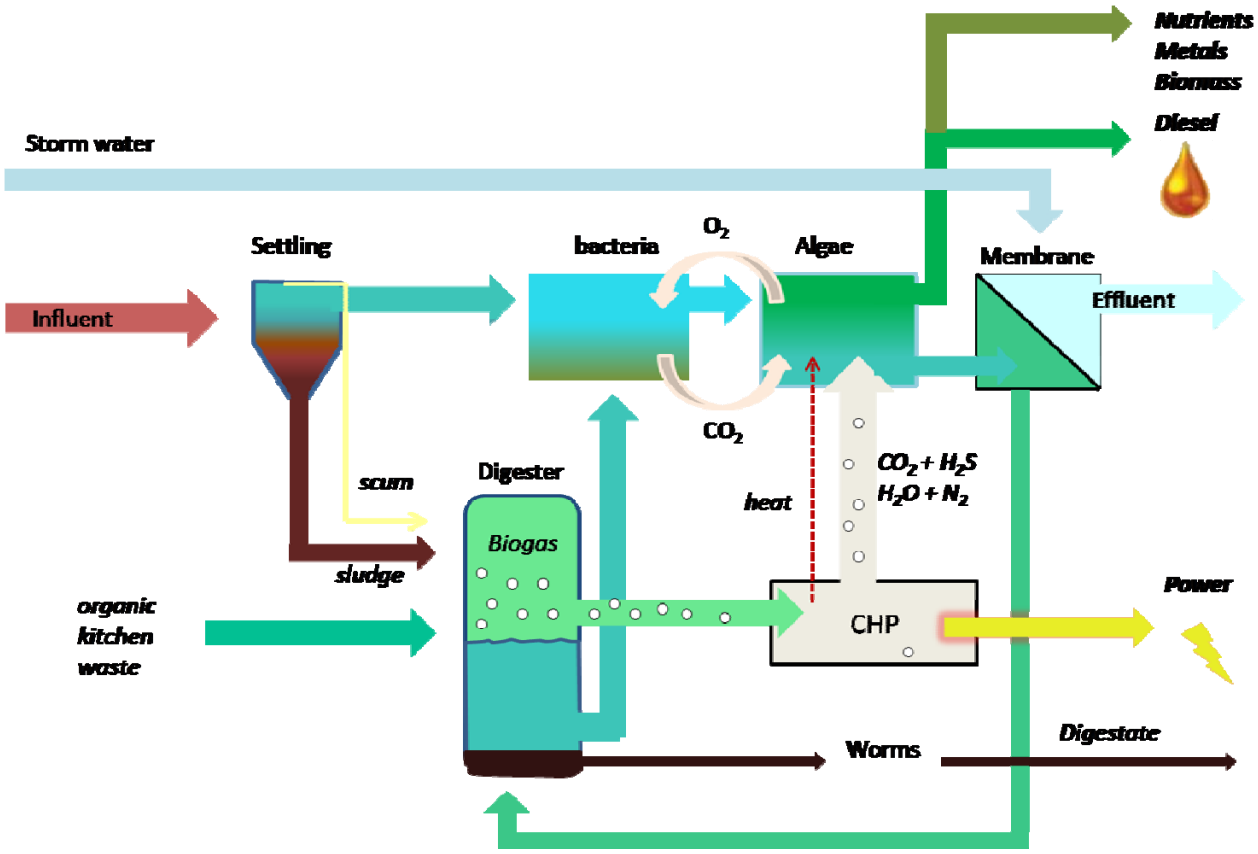
In waste water treatment bacteria are already used to clean, but algae aren't. Bacteria, aerobic and anaerobic, bio-flocculate and ferment the biodegradable organic material. Algae clean every other pollutant in the remaining wastewater. They grow on nutrients, sequester heavy metals, remove the offensive odour, change the colour, removing some pathogenic organisms and even with all these functions performing simultaneously, they are capable of storing energy instead of using it. Algae are typically autotrophic organisms and thus capable of photosynthesis, creating complex organic compounds (such as carbohydrates, fats, and proteins) and supplying oxygen out of carbon dioxide and other organic material capturing energy from sunlight. Algae are one of the world's oldest and evaluated species. Being simpler organisms algae can adapt to any conditions and grow. Algae can tolerate and grow in salt waters, waste water and even in toxic industrial effluents.

Because algae and bacteria are each other's other halves in bioremediation, the lack of algae and their treatment abilities are compensated today by brute force: lots of chemicals and fossil energy. Extensive use of chemicals for waste water treatment results in huge amounts of sludge which takes credit for 25-30% of the total treatment expenditure.

We need to introduce algae in treatment and let them do what they're made for: cleaning water. Algal technology avoids use of chemicals and the whole process of effluent treatment is simplified. There is considerable reduction in sludge formation.

Algae are the keystone for optimal usage of waste water treatment flows. They can clean water and supply oxygen which is required for biodegradation, thereby fixating carbon-dioxide which is released during biogas combustion. They even could supply energy and make a good use of surplus heat. Optimal temperatures are between 20 and 30º C, temperatures which not often occur naturally in the Netherlands.

Schematic the system of my concept is shown in this figure:



The inflows are: 1.influent consisting of combined grey and black water, 2. The storm water which can be separated from the sewer and 3. organic kitchen waste which is perfect fermenting material.

The influent undergoes four treatment parts: at first the separation of sludge and scum, secondly the biodegradation and flocculation by bacteria, thirdly it will be subjected to algae treatment and at last it will be pressed through a membrane. Effluent will probably be cleaner than it is by conventional treatment. It could possibly reach or be upgraded to drinking water quality but this has to be researched.

The storm water only requires the removal of heavy metals. These are originated from gutters and streets. Therefore storm water is introduced right before the membrane.

The collected sludge, to which organic kitchen waste is added, is fermented resulting in biogas, digestate and a liquid part. The liquid part will be further treated to effluent. The digestate will probably contain some toxic materials; research maps out it's components and it's possibilities. The digestate which is left after digesting sludge from conventional treatment is incarnated and therefore it's volume is to be reduced as much as possible. In my concept this could be done by sludge worms, reducing the digestate for up to 75%.

The biogas is led to a CHP, a motor which generates electricity from gas and heat. Remaining gasses and reaction products could provide algae in their need for elements. Surplus heat is also led to algae and if this is more than the requirement of algae, it could sell heat to the neighbourhood . The algae have an high oil-content which could be turned into a variety of products including diesel. Harvesting algae and recover the materials they extracted is still a subject of research. Algae are already cultivated for its diesel without its functioning in waste water treatment.

As you've probably noticed, the system still has to be tested if the practice is corresponding with the theory. This will I do as soon as possible. Parts of the system have already been subject to research, the potency of algae treating waste water for instance. They turned out to be very effective. A good example of research is shown in *'Application of phycoremediation technology in the treatment of wastewater from a leather-processing chemical manufacturing facility*'.

This is the moment for investing in the decentralised ecological manufacture, for investments have to be made anyway. An increasing amount of sewers have to be renovated, WWTP's will need to be redesigned in near future to comply to European standards, in particular regarding the raw-material scarce and climate change and besides the tax payers will force us to.

The decentralised ecological manufacture has even more potential for developing countries and growing economic forces such as India and China, where enormous efforts are made to improve wastewater treatment. There a lot of new waste water treatment systems are to be constructed. Economically, this will be even more interesting.

This concept might be the way for wastewater treatment to get sustainable and profitable.

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