

EHITUSTEADUSKOND
KESKKONNATEHNIKA INSTITUUDT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2014

1. Instituudi struktuur.

Instituudi direktor Enn Loigu

- Keskkonnakaitse aluste õppetool, Chair of Environmental Protection , Enn Loigu
- Kütte ja ventilatsiooni õppetool, Chair of Heating and Ventilation, Hendrik Voll
- Veetehnika Õppetool, Chair of Water Engineering, Karin Pachel
- Veekvaliteedi teadus- ja katselaboratoorium, Laboratory of Water Quality, Kati Roosalu

2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

(NB! Punktid 21.-2.6 täidab struktuuriüksus!)

2.1. Struktuuriüksuse koosseisu kuuluvate uurimisgruppide teadustöö kirjeldus (2.1.1) ja tähtsamad teadustulemused (2.1.2) inglise keeles.

Chair of Environmental Protection

BONUS project "Microalgae - Cost efficient algal cultivation systems – a source of emission control and industrial development"

Department of Environmental Engineering (TUT) - the project Lead Partner.

Description of work in 2014:

- General management of the project (signing the consortium agreement and getting started, creation of project website, holding of 2 project meetings, general management and coordination of project work plan, coordination of project financial issues).
- Compilation of the first 2 deliverables:
 - 1.1. Report on the selection of wastewaters
 - 5.1 Report on local runoff sources and wastewaters in the Baltic Sea Area

The Project „**Assessment of possible changes of Estonian climate and environmental status on the basis of dynamical modeling of atmosphere, ocean and river runoff (EstKliima)**“ under KESTA programme is completed in December 2014.

Project was financed by ARHIMEDES foundation. During the project period pollution load to the Baltic Sea of selected parameters were estimated for the long-term period of 1992-2013. Trends were positive in most cases, however not significant for all sites. Phosphorus loads

were modelled for three different scenarios under climate change conditions. Modelled results showed phosphorus load increase up to 15-20%.

Within the project a research paper was published:

Diana Sarauskiene, Jurate Kriauciuniene, Alvina Reihan & Maris Klavins (2014): *Flood pattern changes in the rivers of the Baltic countries*, *Journal of Environmental Engineering and Landscape Management*, DOI:10.3846/16486897.2014.937438

To link to this article: <http://dx.doi.org/10.3846/16486897.2014.937438>

Under preparation, as general outputs from the project, is the article the heading of which is still not finally decided.

“Regime shift of the climate system in the Baltic Sea region or Climate system in the Baltic Sea region: (Recent) regime shift and impacts on (marine) biota”.

Project participants are: Alvina Reihan (Assoc. Prof.), Kristjan Piirimäe (researcher) and Rain Elken (PhD student), who worked for the project until September 2013. The Participants from TUT I Department of Environmental Engineering attended project meetings and some other project topic related events.

Hydrochemical monitoring of North Estonian rivers in 2014. Methodological guidance of the laboratories participating in the state monitoring programme. Comparison of the water quality of the rivers belonging to the state monitoring programme to the requirements in the international and Estonian legislation. Determination of the state of rivers on the bases of physical and chemical quality indicators and compilation of the annual report.

Chair of Heating and Ventilation

Chair of heating and ventilation mainly focuses on the research in HVAC systems, indoor climate of the buildings and energy efficient and sustainable buildings. The head of the chair Prof. Hendrik Voll is a member of Nearly Zero Energy nZEB Research Group lead by Prof. Jarek Kurnitski. Hendrik Voll's area of research in the research group is passive cooling systems. Hendrik Voll was also awarded with personal research grant PUT (Daylight and solar shading principles for nearly zero energy buildings in cold climates) for the years 2015-2018. Visiting Professor Teet-Andrus Kõiv is a senior personnel with the Institutional research grant IUT 1-15 Nearly-zero energy solutions and their implementation on deep renovation of buildings. Research activities of prof Kõiv are mainly focussed on heat supply systems (heat pumps) of nZEB.

Main achievements:

KESTA (Development of efficient technologies for air exchange and ventilation necessary for the increase of energy efficiency of buildings).

The project ended in 2014. The project studied the work conditions of room-based ventilation units with heat recovery in renovated multi-storey apartment building and defined the characteristics of two units with different operating principles and analyzed the performance of the units based on the results obtained.

The main finding of the research was that the pressure difference between the indoor and outdoor air in the bottom floor apartment depends heavily on the outdoor temperature, indicating the influence of the stack effect, whereas on the top floor, due to the smaller height of the exhaust ventilation shaft, the dependence is weak. Pressure difference caused by wind can be dominant also for longer periods. Although the wind-induced component varies in a wide range and depends on multiple variables, its contribution to the pressure conditions can be considerable, and thus special attention needs to be paid to buildings in wind exposed locations. The simulation results show, that in cold periods, the first floor apartments can be under negative pressure as high as -20 Pa for longer periods of time. For ventilation systems designs in five-storey buildings, where room-based units are to be used, design values of negative pressure should be considered: -10 Pa in fifth floor, -15 Pa in third floor and -25 Pa in first floor apartments.

The outcome of the project was introduced in 3 public seminars in Tallinn and Tartu.

As an outcome , one 1.1 category article was published

Simson, R.; Mikola, A.; Koiv, T.-A. (2014). The Impact of Air Pressure Conditions on the Performance of Single Room Ventilation Units in Renovated Multi-storey Apartment Buildings. International Journal of Ventilation, 10(11), 227 - 236.

Also one 1.2 category article was published

Simson, R.; Annus, I.; Mikola, A.; Koiv, T.-A. (2014). Investigating Airflow Patterns near Supply and Exhaust Vents of Room-based Ventilation Unit using Laser Doppler Anemometry. European Scientific Journal, 10(11), 227 - 236.

Besides, in 2014 the chair of heating and ventilation was involved with numerous small consultancy projects.

Chair of Water Engineering

TheINTERREG project SUSBIO “Sustainable utilization of waste and industrial non-core materials” was completed in 2014 (<http://susbio.turkuamk.fi/>). The SUSBIO project aimed to develop tools for added sustainability of the food value chain in order to reduce the total environmental load on the Baltic Rim area. The project is in line with the EU waste framework directive (2008/98/EC9) and was performed in partnership with Turku University of Applied Sciences (leading partner). TUT participated in project as responsible partner for WP2 and WP4. Met goals: Data of biodegradable waste quantities was collected and the waste treatment investigated. Estimation of the qualities and quantities of biodegradable waste in Estonia and its potential for biogas production have been done; Separate collection of municipal solid waste in Tallinn, changes in collection system waste composition have been analysed The database model for evaluation of biogas production perspectives in Estonia was created and preliminary optimization method for biomaterial utilization for biofuel was carried out. The anaerobic digestion process has been analysed using the specially made, also purchased (AMPTS II) laboratory equipment. Screening experimental methods were examined and from available experimental methods, the bio-methane potential (BMP) tests are those that have been most successful, mainly thanks to their easy set up and conduction as well as the useful information obtainable from them. The tests were conducted either with

pure substrates or a mixture of two substrates in order to investigate also the effect that the combination of different organic wastes have on the digestion process (co-digestion). The research for optimal parameters in biogas production applying single and multistep procedures was carried out. The investigation of opportunities to utilize the solid residues from biogas production in agriculture and the corresponding regularity were investigated. The technical manual of biogas production was drafted. The substrates used in laboratory experiments were sludge from wastewater treatment plant, glycerol, food industry wastes. The final report of project (of the part, in which TUT was responsible) was done by the end of I quarter of 2014.

Tallinn stormwater monitoring The goal of the study was to monitor and assess the flow rate and quality of stormwater, for measuring the extent and trends of pollution, the load of pollutants falling into the sea in time-period between 2012 and 2014. This will enable to plan suitable measures for improving the state of the sea. Monitoring is carried out in 6 sampling stations 6 times per year with different weather conditions. The water quality in Mustoja cannot be considered good due to very high anthropogenic load /impact in the drainage area. Higher content of phosphorus was evident in samples from several collectors throughout the whole monitoring period. The analyses of the diurnal fluctuations of the loads indicated, that the highest loads were those in the outlets of „Russalka“, „Ülemiste“, „Mustjõe“. Final report and previous years reports and final report are available on Tallinn City webpage <http://www.tallinn.ee/est/Veemajandus-Tallinna-linnas> .

Monitoring the Lake Harku. According to the initial task, samples were taken and flow rate measurements done 5 times per year during the monitoring period. Unstable parameters were determined in 17 different stations in situ (in the field). Suspended solids, BOD₇, COD(Mn), NH₄⁺, N_{tot}, P_{tot} and chlorides were determined in vitro (in the laboratory). According to the calculated pollution loads, it is evident, that (as it was expected) the biggest pollution load into the lake originates from the spring high tide, and the lowest pollution load during summer and the most highly polluted point is the mouth of the stream Harku. Water quality in the catchment of the Lake Harku and lake itself is moderate. Final report and previous years reports are available on Tallinn City webpage <http://www.tallinn.ee/est/Veemajandus-Tallinna-linnas>.

Baltic Flows. Seventh Framework Programme FP-7 project Monitoring and management of flowing rainwater in Baltic Sea catchment areas started in October 2013 and is planned to finish in September 2016.

The objectives of the project are to assess storm waters runoff and quality involving local citizens. TUT DEE is involved in the following work packages: 2, 3, 4, 5 and 6, namely development of stormwater monitoring cluster, urban stormwater management, monitoring via Citizen Activity and formulation of a Joint Action Plan. Altogether 45 organisations participate in the project, including 14 project partners from five European regions - Estonia, Finland, Germany Latvia and Sweden, one partner from UK, specialised in the Chinese environmental sector and 28 supporting partners, incl. from the third countries. In 2014, among other works, two reports „Interim report on new knowledge on stormwater management through rainwater harvesting” and “Interim report on new knowledge on diffuse load monitoring” were compiled according to harmonised template about Estonian situation.

Monitoring water quality, pollution load and storm water in the Mustoja catchment area. This is an investigation of stormwater quantity and quality, their formation characteristics, possible engineering solutions for stormwater transport, treatment technologies to prevent and decrease (minimise) pollution load. Project duration is October 2014 – March 2016.

Studies on the quantity and quality of stormwater in Mustoja catchment area in Tallinn: Monitoring of water level, precipitation, water quality – chemical and microbiological parameters, heavy metals, sediments composition. Sampling frequency for water quality is once per week as average. In November 2014 monitoring program was started.

Research on method for removal of nitrogen and phosphorus by segregated activated sludge communities in a two-staged biological wastewater treatment plant. Karl Imhoff used two-stage activated sludge treatment plant in Germany in 1955. It was provided to diminish the capacity of aeration basins. Later this method was patented by Botho Böhnke in 1978 to enhance nitrogen removal capability. In our case, this method is linked together with A2O or (AAO) method due to both nutrients (nitrogen and phosphorus) is removed. Novelty lies in use of segregated activated sludge in both stages and in clarified water containing nitrates being led from the final sedimentation basin back to the anoxic zone, where conversion of adenosine diphosphate into adenosine triphosphate takes place. The method is perspective in the conditions of cold climate regions.

Landfills leachate quantity and quality. Sustainable treatment technologies and technical solutions to fulfill increasingly stringent requirements.

2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

- *Arvo Iital^a, Marija Klõga, Margus Pihlak, Karin Pachel, AndreZahharov, EnnLoigu, 2014. Nitrogen content and trends in agricultural catchments in Estonia. Agriculture, Ecosystems and Environment, 198, 44-53.*
- *Kuusik, A.; Pachel, K.; Kuusik, A.; Loigu, E.; Tang, W. Z (2014). Reverse osmosis and nanofiltration of biologically treated leachate. Environmental Technology, 1 - 11.*
- *Simson, R.; Mikola, A.; Koiv, T.-A. (2014). The Impact of Air Pressure Conditions on the Performance of Single Room Ventilation Units in Renovated Multi-storey Apartment Buildings. International Journal of Ventilation, 10(11), 227 - 236.*
- *Koiv, T.-A.; Mikola, A.; Palmiste, Y. (2014). The New Dimensioning Method of the District Heating Network. Applied Thermal Engineering, 71(1), 78 - 82.*
- *Seinre, E.; Kurnitski, J.; Voll, H. (2014). Quantification of environmental and economic impacts for main categories of building labeling schemes. Energy and Buildings, 70, 145 - 158.*
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2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

Professor Hendrik Voll achieved Estonian Science Communication Award

Professor Hendrik Voll was awarded with personal research grant PUT (Daylight and solar shading principles for nearly zero energy buildings in cold climates) for the years 2015-2018