

# Modelling nutrients, energy and growth in aquaponic systems

## Training School Report

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### Sunday 23<sup>rd</sup> April 2017

There was an 'ice-breaker' event at The River Lee Hotel which was attended by all the participants and trainers.

### Monday 24<sup>th</sup> April 2017

08:30 - 09:00	Registration
09:00 - 09:15	<b>Welcome</b> to BEES/ERI – Prof. Sarah Culloty (Head of School of BEES)
09:15 -10:00	<b>Tour de Table.</b> The Training Team and Trainees presented their background and their research interests and told us what skills they hoped to gain from the workshop
10:00 - 10:30	<b>The EU Aquaponics Hub COST network</b> – aims and activities. The workshop coordinator, Gavin Burnell, gave an overview of the network
10:30 - 11:00	Refreshments
11:00 - 12:00	<b>An Introduction to Aquaponics.</b> One of the trainers, Simon Goddek, gave his interpretation of this topic as a background to the model that he was going to present
12:00 - 13:00	<b>An Introduction to mathematical modelling of biological systems.</b> Dr James Savage, a postdoctoral researcher from UCC, gave a useful overview the types of models available. He also explained some of their limitations
13:00 - 14:00	Lunch
14:00 - 15:00	<b>Modelling Theory (1)</b> – Causal Loop Relationships. Simon Goddek described his aquaponics research and why he advocates de-coupled systems
15:00 - 15:30	Refreshments
15:30 - 17:30	<b>Modelling Theory (2)</b> – Causal Loop Relationships and Introduction to <i>AnyLogic</i>

## Tuesday 25<sup>th</sup> April 2017

09:00 - 11:00	<b>Practical Session with <i>AnyLogic</i> (1)</b> – The students were able to get hands-on experience with <i>AnyLogic</i> by carrying out various practical training exercises on their own computers using this free software
11:00 - 11:30	Refreshments
11:30 - 13:00	<b>Practical Session with <i>AnyLogic</i> (2)</b> – Simon Goddek
13.00 - 14.00	Lunch
14:00 - 16:00	<b>Introduction to The Virtual Greenhouse (VG) model.</b> The theory for the second model was introduced by Dr Oliver Körner
16:00 - 16:30	Refreshments
16:30 - 18:00	<b>Demonstration of Virtual Greenhouse model.</b> Dr Oliver Körner made a training version of his model available to the students who were able to try out various scenarios. This model had been developed over 10 years and was developed by using the MATLAB programme. Free versions of MATLAB had been kindly made available for one month to the Training School by Robert Boswell of MathWorks

## Wednesday 26<sup>th</sup> April 2017

09:00 - 11:00	<b>Introduction to MATLAB model.</b> Dr Kai Wagner showed how MATLAB could be used to develop a very different model to the Virtual Greenhouse one. His approach centered more on the available nutrients in fish-based rather than plant-based systems. This gave the students another perspective on how computer simulations can help us to understand processes and also predict possible scenario outcomes
11:00 - 11:30	Refreshments
11:30 - 13:00	<b>Practical Session with MATLAB model.</b> The students gained more practical experience by running simulations on their own computers
13:00 - 14:00	Lunch
14:00 - 15:30	<p><b>Visit to the Environmental Research Institute (ERI) :</b></p> <p>14:00 Welcome &amp; Introduction from Dr Paul Bolger (Manager, ERI)</p> <p>14:15 Dr David Wall 'Bioenergy and Biofuels Research Group'</p> <p>14:30 Richard O'Shea 'Greening the Gas Grid' Shane McDonagh 'Power-to-Gas: 3rd generation gaseous biofuel'</p> <p>14:45 Jamie Fitzgerald 'Bio-reactor Ecology - Microbial Community Characterisation, Analysis and Extrapolation'</p> <p>15:00 Shane McDonagh 'Power-to-Gas: 3rd generation gaseous biofuel'</p> <p>15:15 Beatriz Gil Pulido 'Microbial ecology of a bioreactor approach to treat Dairy Wastewater'</p>

15:30 - 15:45	Refreshments
15:45 - 16:30	<p><b>Training School Participant presentations:</b></p> <p>15:45 Frederic Lapierre: The potential of microalgae for bioremediation in integrated aquaculture</p> <p>16:00 Christopher Williams: A Viability Assessment of Aquaponics Production in Iceland</p> <p>16:15 Jan Eike Kramer: EU – InnoAquaTech Decision - Support Tool</p>
1400 - 18:00	All the Training School participants visited UCC's Environmental Research Institute. The first part of the proceedings was a mini-symposium at which various researchers presented work of cognate interest to aquaponics. This centered around recycling waste in bioreactors as another example of the circular economy. In the second half three of the Training School participants presented their own work. Finally there was a tour of the ERI including an inspection of the bio-reactors by Dr David Wall.

### Thursday 27th April 2017

09:00 - 1045	<p><b>Q and A session followed by Roundtable Discussion.</b> A panel of the trainers answered questions on their respective presentations. The course coordinator Gavin Burnell then facilitated a discussion on various issues that arose during the 4-day workshop. Some of the subjects addressed included: the virtues of MATLAB versus AnyLogic; the importance of microbial communities in recirculation systems; the commercialisation of models; the need for a standardisation of model parameters; funding sources for model development (e.g. MarieCurie, COST and Eurostars)</p>
11:00 – 16.30	<p><b>Visit to Bantry Marine Research Station.</b> All participants took a coach trip to a small research station in west Cork that is running several EU research projects. These included sea urchin and sea cucumber hatchery trials, various macroalgae cultivation trials and a lumpfish disease trial. Dr Daryl Gunning gave an excellent introduction, followed by an informative guided tour. Workshop participants were able to see practical examples of some of the theoretical systems that they had studied during the previous three days</p>
20:00	Farewell Dinner at The Oliver Plunkett. The final highlight was a taste of Irish hospitality and entertainment in the form of a cabaret-style evening of traditional music and dancing

### Friday 28<sup>th</sup> April 2017

Trainees departed

## Feedback

*This has been one of the most excellent and informative trips I have gone on in such a long time and I could not even begin to express how absolutely lovely everybody is and the extent to which Cork is a town that just resonates with charming people. The COST Network and its participants are absolutely incredible people with such a large breadth of talents.*

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*I have found this course as being very useful for me and therefore, a serious of unclear issues were clarified after this training school. Thank you for offering me this chance.*

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*For me it was a great pleasure to have had the opportunity to participate in this Cost training action. In my opinion when doing modelling we are contributing to produce something that can easily be used by those who are interested in using the same process but with different parameters ... I also want to wish you congratulations for all the efforts you had in organizing this event, for me it was perfect.*

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*Thank you so much for having me at the Training School in Cork! It was an amazing and inspiring experience for me! I learned so much in so many regards! Of course from the (really good) presentations and training sessions, but also from the more informal discussions along the side. The most interesting thing for me was to discover the synergies and common problems in how people with different backgrounds approach a very complex system from very different directions and with different perspectives. Truly inspiring! Also I enjoyed to get some in-depth hands-on experience with different kinds of models. This definitely increased my understanding and encouraged my creativity in the modelling process. Nevertheless I consider the opportunity to meet people with similar goals from all over Europe, connect with them and explore possibilities for future collaborations as even more valuable than all the knowledge-transfer. So again, thank you for making this possible!*