Tools for Assessment and Planning of Aquaculture Sustainability

SHORT TITLE:	**TAPAS**
COORDINATOR:	**Prof. Trevor Telfer**
ORGANISATION:	**University of STIRLING, UK**
TOPIC:	**H2020- SFS-11b-2015**
PROJECT NUMBER:	**678396**

DELIVERABLE: 3.3

Workshop on model development and design of case studies (D.3.3)

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

TAPAS Tools for Assessment and Planning of Aquaculture Sustainability	**Tools for Assessment and Planning of Aquaculture Sustainability : TAPAS (Grant No. 678396)** **FS-11B-2015. Consolidating the environmental sustainability of European aquaculture** **TAPAS WP3 workshop** **Monday, 3rd April 2017.**

Contributing Authors:

Trevor Telfer (UoS), Lynne Falconer (UoS), Adam Lillicrap (NIVA), Ricardo Torres (PML), Andreu Rico (IMDEA), Kostas Tsiaras (HCMR), Manolis Tsapakis (HCMR), Dave Jackson (MI), Ioannis Mamoutis (MI), Frank Kane (MI), Steef Peters (WI), Joanna Casserly (MI), Nuria Garcia Bueno (UM), Arnaldo Marin Atucha (UM), Tamás Bardócz (ABT), Tania Teixeira (ABT), Ines Pimparel (ABT), Árpád Ferincz (SZIU), András Ács (SZIU), Adam Staszny (SZIU), Mechteld ter Horst (ALT), Paul van den Brink (Chair) (ALT).

History of changes:

Ver	Date	Changes	Author
0.1	03.04.2017	First version	Mechteld ter Horst (ALT)
0.2	03.04.2017	Review/edits	Paul van den Brink (ALT)
0.3	07.04.2017	Review/edits	Arpad Ferinczs (SZIU) Manolis Tsapakis (HCMR) Lynne Falconer (UOS) Arnaldo Marin Atucha (UM) Trevor Telfer (UoS) Andreu Rico (IMDEA)
0.4	14.04.2017	Review/edits	Mechteld ter Horst (ALT)
0.5	05.05.2017	Review/edits	Trevor Telfer (UoS)
0.6	05.08.2017	Review/edits - removing powerpoints of partners hosting a case study due to confidentiality issues. Powerpoints can be provided upon request.	Mechteld ter Horst (ALT)

Refer to this document as:

Ter Horst M.M.S., Van den Brink P.J., Ács A., Bardócz T., Casserly J., Falconer L., Ferincz A., Garcia Bueno N., Jackson D., Kane F., Lillicrap A., Mamoutis I., Marin A., Peters S., Pimparel, I., Rico A., Staszny A., Teixeira T.T., Telfer T.C., Torres R., Tsapakis M., Tsiaras K., 2017. Workshop on model development and design of case studies. EU H2020 TAPAS Deliverable 3.3. Report. 91 pp.

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

1. Introduction and agenda of the workshop

1.1 Introduction

This report describes the outcome of the workshop on model development and design of the case studies (D3.3) that took place in Malta on 3 April 2017. This workshop builds upon the results of the WP3 workshop in October 2016 (D3.2: workshop to evaluate existing models for the environmental risk assessment of chemicals used in aquaculture in the EU). During the workshop in October 2016 it was agreed to organise in conjunction with WP5 and WP7 a meeting in early spring 2017 to discuss and make detailed protocols in order to align the case study designs and experiments.

Deliverable 3.3 (Workshop on model development and design of case studies) is part of Task 3.2 of WP 3: The development of an improved modelling approach for the ERA of potentially toxic substances and Task 3.5 of WP3: Model and scenario validation through case studies.

Task 3.2 is the development of an improved modelling approach for the ERA of potentially toxic substances. Partners involved are: ALT, IMDEA, PML, HCMR and UOS. In addition, NIVA, UM, ABT will not be main partners but will contribute to the modelling strategy by participating in the workshops as well. University of Stirling would provide input partly via a PhD student funded by TAPAS. Task 3.5 is the model and scenario validation through case studies. Partners hosting a case study are: HCMR (Marine net pens/cages in Mediterranean sea – Greece), SZIU (Fresh water fish ponds Hungary), UM (Marine net pens/cages in Mediterranean sea – Spain), NIVA (Marine net pens/cages in North sea – Norway).

Prior to the workshop each partner hosting a case study prepared a presentation specifying as far as possible a proposal and detailed protocols for their case study. These presentations were used as basis for further discussions considering the case studies (e.g. (lab) facilities, help/input from other partners needed, timing/planning of activities) and the modelling.

It was agreed to further share and discuss detailed protocols via email. With each case study partner ALT will organise follow up meetings (either skype or face-to-face) to review preliminary results of the measuring campaigns in 2017, to discuss the modelling strategy and to possibly discuss any field work in 2018.

Alterra provided an introduction to the aims and goals of the workshop and this presentation can be found in Annex 1. Presentations of the different partners hosting a case study can be provided upon request. The agenda is given in the next section (1.2) and the minutes of the workshop are given in chapter 2 of this report.

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

1.2 Agenda of the workshop

The workshop has been organized by ALT in Malta on Monday 3 April 2017. The agenda of the workshop is given below:

AGENDA:

Monday 3rd. Venue: Plaza Hotel, Tower Road, Sliema, SLM 1605, Malta			
No.	Approximate time	Topic	
1.	8.30	Welcome and Introductions	ALT
2.	9.00	Presentation and Discussion Case study Greece	HCMR
	10.30	Coffee break	
3.	10.50	Presentation and Discussion Case study Hungary	SZIU
	12.20	Lunch	
4.	13.30	Presentation and Discussion Case study Spain	UM/IMDEA
	15.00	Coffee break	
5.	15.20	Presentation and Discussion Case study Norway	NIVA
6.	16.50	Wrap up	ALT
7.	17:10	Close	

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

2. Minutes of the workshop

In attendance: Trevor Telfer (UoS), Lynne Falconer (UoS), Adam Lillicrap (NIVA), Ricardo Torres (PML), Andreu Rico (IMDEA), Kostas Tsiaras (HCMR), Manolis Tsapakis (HCMR), Dave Jackson (MI), Ioannis Mamoutis (MI), Frank Kane (MI), Steef Peters (WI), Joanna Casserly (MI), Nuria Garcia Bueno (UM), Arnaldo Marin Atucha (UM), Tamás Bardócz (ABT), Tania Teixeira (ABT), Ines Pimparel (ABT), Árpád Ferincz (SZIU), András Ács (SZIU), Adam Staszny (SZIU), Mechteld ter Horst (Alt), Paul van den Brink (Chair) (Alt).

No.	*Topic*	*Discussion*	*Actions*
1.	Welcome	*Powerpoint Paul van den Brink (Alterra) – see Annex 1*	
2.	Presentation and Discussion Case study Greece	*Powerpoint Manolis Tsapakis (HCMR)* 2 case study sites: 1. Experimental fish farm, 2. Allocated zone of aquaculture (full access to facilities of fish farms in the zone) – Vourlias Bay 2. Vourlias bay – will be used for WP3. Work done so far: data gathered, fish feed (kg), several nutrients (see ppt). Model to calculated output of fish farms is ready (nutrients). First ecological survey of area (which organisms found where). For WP5 the AIM model (nutrients) might be used (Kostas Tsiarias). It is possible to link this model to pharmaceuticals or metals. AIM is an effect model. But there are many models to choose from: DEPOMOD/DEPOCHEM, AIM, MAMPEC (deltaris). Discuss modelling later this year. 7-11 July 2017 – measuring campaign: - Physical chemical - Copper based antifoulings = target - If antibiotic used – help of Alterra needed – need to make protocols - Disinfectants not important, because not used much - Discuss antibiotics testing with IMDEA Effect models are needed --> Alterra can help Preferably integration of nutrients and chemicals in the effect model. Considering exposure a plan is worked out for modelling. A more detailed plan for chemical exposure modelling is needed. Copper: much data is available, so experiments are not really needed. Need to discuss space and time of	• **HCMR (Manolis):** sends a sample of fish feed to Alterra • **Alterra (Paul)** : will analyse the fish feed considering by-products (PAH, dioxins). • **Alterra (Paul) + HCMR (Manolis):** Organize later this year a meeting/workshop in Greece to discuss the effect modelling, the preliminary results from 2017 and the adjustments for 2018 (include WP5) • **HCMR (Manolis)** share detailed protocols with other TAPAS partners (before start of measuring campaign) • **HCMR (Manolis) + Alterra (Paul)** : Manolis to send list of likely antibiotic to be used, Paul to prepare a protocol for this antibiotic

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396
The European Union

		effects. Maybe PAH and dioxins in fish feed are also a problem. Alterra to analyse them in fish feed as this is applied heavily (100 t/d)	
3.	Presentation and Discussion Case study Hungary	*powerpoint András Ács (SZIU)* Slide – "*Ex situ* and lab assessments 2" - Also test concentrations higher than the environmentally relevant concentrations - Idea is to test a mixture of the three selected antibiotics on the most sensitive species Slide – "*Ex situ* and lab assessments 3" - Exposure: take 4 days instead of 3. Use longer exposure duration in experiments since these chemicals are chronically toxic, large difference between acute and chronic toxicity - Also test concentrations higher than the environmentally relevant concentrations - Experience Andreu : macroinvertebrates are sensitive in order of mg/L - Idea: look at indirect effects – effects on microbials on the leaves, feed the leaves with affect microbials to the macroinvertebrates Slide – "*Ex situ* and lab assessments 4" - FET test sediment – wonder whether you will see much effects – better to use other endpoints? Possible to include test with Chironomus? A test protocol (OECD 218, 219 and 233) and an individual based model exists (Alterra) Slide – "*Ex situ* and lab assessments 5" - If one of the biomarkers does work as an early indicator of stress, this biomarker could be used in the toolbox Slide – "*In situ* assessments – antibotics resistance genes in carp ponds" - Sediment sampling: for chemical residues a more frequent sampling scheme is needed. For instance: 1d, 3 d, 7d, 14 d, 4 w, 8 w. Modelling: ERA-AQUA model can be used. Genetic resistance component + entry of substance via manure needs to be included. How does hydrology work? Ponds are filed up end of	• **SZIU (Arpad)**: share detailed protocols with other TAPAS partners (before start of measuring campaign) • **Alterra (Paul) + SZIU (Arpad)** : Organize later this year a meeting in Hungary to discuss the exposure and effect modelling + review preliminary results • **IMDEA (Andreu)** : send list of endpoints needed for modelling with ERA-AQUA

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

		winter. Fish are place in pond end of April. Mostly stagnant system. Additional water is only applied in case of need (much evaporation). Is some years the supply channels dry up and depletion is not possible. Water is pumped out at the time of harvest in October/early November.	
4.	Presentation and Discussion Case study Spain	*Powerpoint Arnaldo Marin Atucha (UM)* Experiment 4 - Advice to measure closer to the farm than 100 m - Sampling of the water column is done for WP5 and WP6 How to link the sampling/measuring to the modelling work? - Idea Paul: use DEBtox model for bioaccumulation and biomagnification - What about exposure? - Farmers do not cooperate, so we do not know what is when applied --> Focus for this scenario on the individual level. The planning seems quite challenging and should probably be adjusted.	• **UM (Arnaldo):** share with partners: protocols, also protocols for WP5&6 (sampling water column – chemicals, antibiotics) • **Alterra (Paul)** : organise skype meeting with Paul, Andreas and Andreu to discuss the effect modelling. Can DEBtox be used? • **UM (Arnaldo):** send adjusted planning
5.	Presentation and Discussion Case study Norway	*Powerpoint Adam Lillicrap (NIVA)* - No concrete plans – what are the requirements for the modelling? - NIVA has a limited budget in WP3 – help from other partners is crucial. - Salmon lice treatments biggest concern. Start of treatments: now – June. - Most interesting type of substances: benzurons and pyrethroids (cypermetrin, deltamethrin), however use of pyrethoids (bath treatment) decreases, so first focus on benzuron. - Benzurons are applied via food – slow release in environment, about a week. Acute studies are meaningless. - Pyrethroids: bath treatment, so quick release; plume, will end up in the sediment, but more dispersed – problem sampling high depths - Trevor has lots of data on cypermethrin - NIVA could use some help with sediment testing. Alterra can step in here.	• **PML (Ricardo)**: discuss existing modelling approaches with Trine • **Alterra (Paul)** : organise a skype call on the modelling development and approach in April • **NIVA (Adam):** map the treatments in 2017 • **Alterra (Paul)** : explore whether chronic sediment experiments can be performed at Alterra • **ABT (Tania):** collect data for the top 5 chemicals used in Norway • **Alterra (Paul)** : send Adam papers on sediment testing • **Alterra (Mechteld):** send Ricardo information on degradation and sorption

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

		Modelling approach - Maybe better to focus on model development by PML (Ricardo Torres) using the available historical data. - Modelling approach can be based on existing data. Calibration/validation of the model is not possible, only get a feeling for the model uncertainty - Whole fjord, or part of fjord – where to put the boundary? - Fish farm input to the model is not possible – organic matter production of a fish farm can be input to the model - Modelling of sediment requires model improvement, incorporating fate processes like sorption and degradation of the chemical as well. - 1 -0.5 km resolution - Won't be able to replicate period of sampling. More of a statistical approach – qualitative comparison – look at decreases/increases - Needed: info on input in water column: rate of input type and input at the surface – WP5 can deliver this via their models - What is ecological target? Crustaceans, zooplankton and phytoplankton - ABT offers to assist NIVA - Endpoints: concentration of chemicals, physico-chemical features, zooplankton, phytoplankton, crustaceans <u>First develop the model on the data that is available and perform the monitoring in 2018</u>	concepts in TOXSWA. • **Alterra (Paul) + NIVA (Adam):** End 2017 / beginning 2018 organise a workshop in Norway on progress modelling and field work in 2018
6.	Wrap up	*See relevant slides from powerpoint Paul van den Brink (ALT) for annual project meeting on April 4th – see Annex 2*	

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

ANNEX 1 powerpoint Alterra (Paul) – Introduction to the WP3 meeting April 3rd, 2017

WP3: Environmental Risk Assessment (ERA) of potentially toxic substances

D3.2 Workshop with relevant project partners to evaluate the ERA models and to design a strategy for their development and improvement.

D3.3 - Workshop with all relevant project partners on the model development and to design the case studies for validation and evaluation

Workshop agenda

Monday 24 October

1.	8.30	Welcome and Introductions ALT
2.	9.00	Presentation and Discussion Case study Greece HCMR
	10.30	Coffee break
3.	10.50	Presentation and Discussion Case study Hungary SZIU
	12.20	Lunch
4.	13.30	Presentation and Discussion Case study Spain UM/IMDEA
	15.00	Coffee break
5.	15.20	Presentation and Discussion Case study Norway NIVA
6.	16.50	Wrap up and presentation tomorrow ALT
7.	17:10	Close

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

People at this workshop

ALT	Mechteld ter Horst, Paul van den Brink
IMDEA	Andreu Rico
UM	Arnaldo Marin Atucha, Nuria Garcia Bueno
NIVA	Adam Lillicrap
HCMR	Manolis Tsapakis, Kostas Tsiaras
SZIU	Arpad Ferincz, András Ács, Adam Staszny
ABT	Tania Teixeira, Tamás Bardócz , Ines Pimparel
UOS	Trevor Telfer, Lynne Falconer
PML	Ricardo Torres
MI	Dave Jackson, Ioannis Mamoutis, Frank Kane, Joanna Casserly

TAPAS

Goals of this workshop

1. Design the case studies for validation and evaluation
   - Which sampling scheme?
   - Which endpoints?
   - Whom involved?
2. Agree on the fate and effect model development
   - Which models and who will do the work?
   - Links with other WPs (e.g. WP5, near field models)

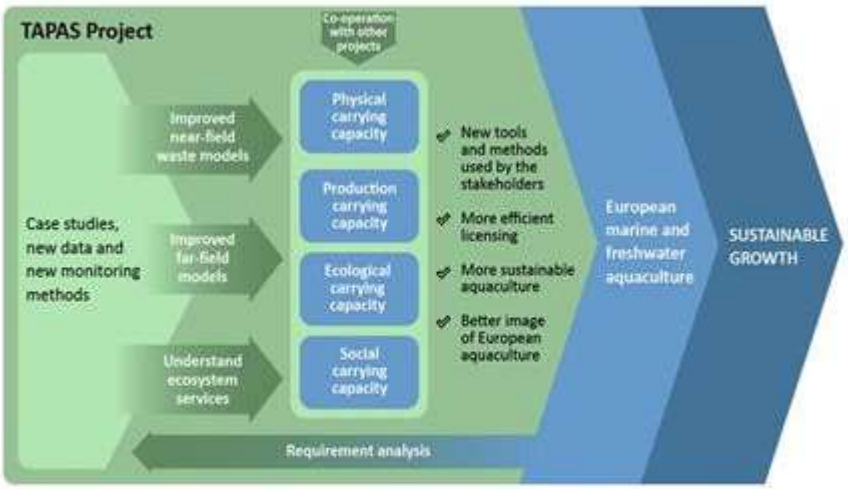
- Only make commitments when time is available (in principle no relocation of time)!

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

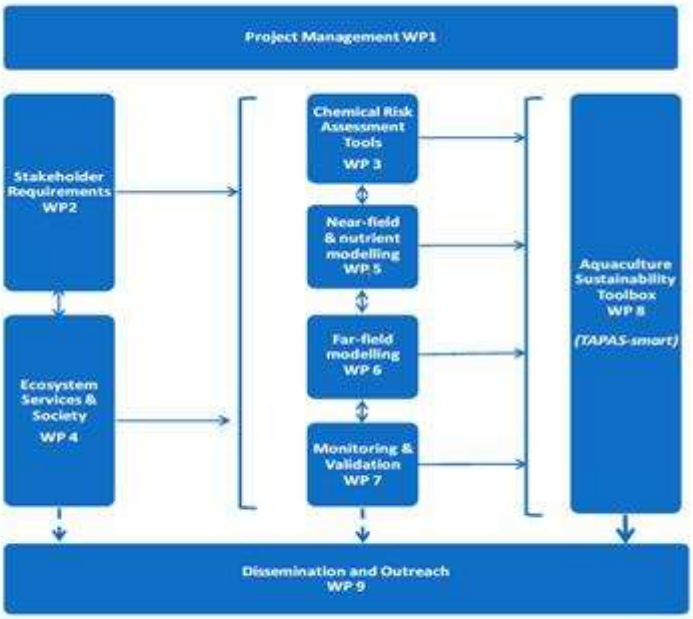
TAPAS



TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

TAPAS



TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

WP3: ERA of potentially toxic substances

Objectives

1. *To evaluate and improve existing farm-scale modelling tools for the evaluation of the ecotoxicological risks generated by antifouling agents, veterinary medicines and potentially toxic compounds.*
2. To compile, develop, and test environmental thresholds for potentially toxic substances used in EU aquaculture.
3. To develop rapid assessment tools for the prospective ERA of potentially toxic substances that can be used by farm applicants and regulators (WP8).

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

WP3: ERA of potentially toxic substances

Tasks

Task 3.1: Literature review of existing models for the ERA of potentially toxic compounds (IMDEA)

Task 3.2: Development of an improved modelling approach for the ERA of potentially toxic substances (ALT)

Task 3.3: Development and evaluation of EU aquaculture scenarios for the ERA of potentially toxic substances (IMDEA, ALT, NIVA, UOS, PML, ASC, SZIU, ABT)

Task 3.4: Development of environmental quality thresholds for ERA (SZIU, IMDEA)

Task 3.5: Model and scenario validation through case studies (ALT, SZIU, UM, ABT, NIVA, UOS, HCMR, PML, IMDEA)

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

Goal 1: Model development

- To assess the impacts of potentially toxic substances (e.g. antifouling agents, veterinary medicines and other biocidal compounds) to aquatic ecosystems surrounding aquaculture farms
- Provide an ecologically relevant link between aquaculture management practices and their associated biological impacts,
- Integrated into appropriate spatio-temporal scales to assess the assimilative capacity of ecosystems and the carrying capacity of different production systems
- Close cooperation with WP5 (near field models)
- University of Stirling would provide input partly via PhD student not funded by TAPAS. Plymouth Marine Lab can contribute and many other would like to be discussion partners.

TAPAS

Goal 2: Case studies

- Four experimental studies (a freshwater case study, and three marine in the Mediterranean sea, east and west, and in the North sea) will be carried out
- Aims:
  - to calibrate and evaluate the different components of the modelling tools derived in Task 3.2,
  - to evaluate the efficiency on the implementation of the modelling scenarios generated in Task 3.3,
  - and to test the environmental threshold concentrations and evaluation endpoints derived within Task 3.4.
- Case studies sites are selected: NIVA, UM and HCMR as marine systems and SZIU in Hungary for freshwater systems.

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

Goal 2: Case studies

- Chemical and biological monitoring will be carried out in freshwater and marine ecosystems impacted by aquaculture farm operations
  - basic water quality parameters
  - samples of water, sediment and sediment trays for the analysis of organic matter, redox conditions and contaminants
  - biological composition of benthic invertebrate, macrophyte and fish communities
  - biomarkers of exposure to specific contaminants
- To which extent we can share the case studies with the other work packages?

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Case-study – endpoints - modelling matrix

Case study	Water quality endpoints	Chemical endpoints	Biological and ecological endpoints
Greece	?	?	?
Norway	?	?	?
Spain	?	?	?
Hungary	?	?	?

Case study	Exposure modelling	Effect modelling	Risk modelling
Greece	?	?	?
Norway	?	?	?
Spain	?	?	?
Hungary	?	?	?

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

ANNEX 2 powerpoint Alterra (Paul van den Brink) – wrap-up meeting on design of case studies for WP3

Overview of the Case Study in Eastern Mediterranean (Greece)

Dr. Manolis Tsapakis
Hellenic Centre for Marine Research

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Discussions during workshop

- Copper is the target chemical,
- Antibiotics when applied → we have to make protocols in case they apply them
- Maybe PAH and dioxins in fish feed are also a problem. Alterra to analyse them in fish feed as this is applied heavily (100 t/d)
- Disinfectants are also not used often, not included
- Share protocols for comments
- Modelling using MAMPEC, AIM, DepoChem or DepoMod?
- Alterra to organise small workshop at the end of this year in Greece to discuss preliminary results from 2017, adjustments for 2018 and the effect modelling

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

Effect of manure-related antibiotics on the resistance gene frequency of bacterial community in carp ponds

and

Ecotoxicological characterization of three manure related antibiotics

András Ács, Bence Iványovics, Márta Reining, Árpád Ferincz
Szent István University

Experiments

- Acute and sub-acute experiments using fish (early lifestage), algae and invertebrates
  - Zebrafish embryo's
  - Cyanobacteria
  - Green algae
  - Gammarids
  - Dreissena
  - FET test according to OECD 236
- Use biomarkers as early warning systems

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

In situ assessments – antibotics resistance genes in carp ponds

- According to local veterinarians, most commonly used antibiotics in cattle and poultry farms are: Amoxicillin, Florfenikol and Oxytetracycline
- Characterisation of resistance genes and antibiotics analyses in the manure that is applied
- **Sediment** sampling at least over 2 months after manure application, probably all 2 weeks (resistance genes and chemical residues)
- **fish samples** (e.g. **skin** and gut **content**) and macro-invertebrate samples from control and manured systems for biochemical marker assessments (as described previously: ex situ experiments)

TAPAS

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Discussions during workshop

- Maybe use longer exposure duration in experiments since these chemicals are chronically toxic, large difference between acute and chronic toxicity
- Possible to include test with Chironomus? A test protocol (OECD 218, 219 and 233) and an individual based model exists (Alterra)
- Share protocols for comments
- Modelling will be done with ERA-AQUA with some modification (adding via manure and antibiotic resistance). Andreu to send list of endpoints needed for modelling
- Meeting at the end of the year in Hungary to review preliminary results and modelling

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

Marine case study in Western Mediterranean-SPAIN

Arnaldo MARIN ATUCHA
Nuria GARCÍA BUENO
Andreu RICO ARTERO

Murcia and IMDEA

Experiments (effects of Cu, antibiotics)

- Responses of biofims
- Biofilm grazing by Gammarus and Monodonta
- Sediments traps for macroinvetebrate colonisation
- Medicated feed feeding by Gammarus and Monodonta (bioaccumulation and magnification)

- Metal and antibiotic accumulation in sediment (field)

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Discussions during workshop

- Share protocols for comments
- Modelling can be done at the individual level, bioaccumulation, biomagnificantion
- It would be nice to explore whether DEBtox (dynamic Energy Budget toxicity) modelling could be performed. Alterra to organise a Skype call with Andreas Focks
- The planning seems too ambitious, please adjust

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

Western Norway, Hardangerfjorden Region (NIVA)-Field campaigns in the wider farming area.

Adam Lillicrap
(Ailbhe Macken)

NIVA

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

Discussions during workshop

- Since the resources of NIVA is limited it is unrealistic to plan a field work without help
- Maybe better to focus on model development by PML (Ricardo Torres) using the available historical data this year
- Plan field campaign for 2018 based on model development and available budgets
- Benzuron applied via food seems to be the most relevant chemical stressors
- Alterra to organise Skype call at the end of April to discuss the model development and available data sets
- End 2017 / beginning 2018 to organise a workshop on 2018 field work

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 678396

The European Union