Parma Summer School 2020 "One Health"

Environment & Health in the One Health framework

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ONE Health

“ONE Health” (OH): *conceptual* and *operational* framework linking environment, animals, food-producing chains, human health

Not intended to increase the number of silos but to support cross-fertilization among silos

a *developing* field: multifaceted web of feed-backs and interactions among its components calls for selecting priority issues, for research and for risk analysis avoiding to “drown into complexity”

OH historically stems from *Veterinary Public Health* = the human health implications of animal health (*zoonoses*, first), yet OH is definitely more

Environment is always quoted as OH pillar,
but HOW to interpret it within OH?

Environmental issues are already there

The main ongoing EU initiative is the OH European Joint Programme (OHEJP, https://onehealthejp.eu/)

The OHEJP objective is to reinforce transdisciplinary cooperation and integration in the fields of
Foodborne Zoonoses,
Antimicrobial Resistance
and Emerging Infectious Threats, so...

one might ask:
where is "environment"?

And the answer is:
environmental issues are well represented

Environmental issues are already there

Let's look at the presentations of the (virtual) Annual Scientific Meeting (May 27-29, 2020 ohejp2020.com)
You can pick a number of works searching for zoonotic pathogens and AMR in the ecosystems (wildlife, waste water, seawater) and also
- relationships between tolerance to toxic environmental elements (arsenic, copper etc.) and AMR
- risk perception by residents of intensive livestock farming (noise more perceived than zoonoses)
- the microbiome of slurry-amended grassland

- The WAWES network "Wildlife, Agricultural soils, Water environments and antimicrobial resistance - what is known, needed and feasible for global Environmental Surveillance",

*So, the question is certainly not "if", but "**HOW**"*

while "How" may be considered from several viewpoints,
Let's take it from the standpoint of
Food Safety from Field to Fork ***(which is OH approach)***
Three pathways may be identified here

- **How the environment modulates risk factors**
- **How the agro-farming systems affect the environmental components of OH**
- **How the environment is a source of OH risk factors (*environmental toxicants and OH*)**

***The environment-animal-human web: a "One Health" view of toxicological risk analysis*, dedicated open-access research topic in Frontiersin Public Health, November 2018, ed. C. Frazzoli and A. Mantovani**

The environment modulates OH risk factors

Major example climate changes: events driven by climate changes may increase the availability of toxicants for food-producing organisms (*European Environment Agency, 2018*)

erosion of soils from flooding, heavy rainfall, thawing of frozen soil, forest fires will release mercury from "trapping" compartments (incl. atmosphere, wood) and make it available to aquatic food chains = human exposure to methylmercury (developmental neurotoxicant) through consumption of fish, exp. large, predatory species

- Aflatoxin M1 in milk: vulnerability of plants used as feeds to Aflatoxin-producing fungi related to climate changes and farming practices;

presence of the carcinogenic metabolite AFM1 in milk due to animal metabolism;
human risk related to dietary habits = definitely a OH issue

(*Frazzoli et al., Front Public Health, 2017*)

Agro-farming systems, environment and OH

- *Specific* components of this issue are already in the *EU risk assessment framework*.
Two EFSA Panels (FEEDAP on substances used in animal feeds, PPR on pesticides and other plant protection products) assess substances *intended to* benefit food producing orgamisms by considering both human health risks and potential adverse (short- and long-term) impacts on *organisms living in the ecosystems*, as proxy for the impact on environmental quality/biodiversity: it sounds as OH (eg, EFSA 2014)

The current agricultural systems are under serious scrutiny for their patterns of consumption (water, soil..) and emissions (greeenhouse gases, nitrogen, phosphorus). These aspects impinge on global issues more and more *intertwined with food safety:*

Food security (availability of food of sufficient quality for all)
Sustainability (the environment left to next generation)

(*EEA Report "Food in a Green Light", 2017*)

Environmental toxicants and OH

Human exposure to toxicants as residues in foods of animal origin is a well-established issue,
yet they should be considered as novel zoonoses in a OH perspective
The toxicant derive from the environment and environment-modifying human activities (fall-out of industrial emissions on pastures, use of waste-water or slurry on agricultural lands, etc.)
The human exposure is mediated (and modified) through the animal biology and metabolism, eg., the differential bioaccumulation of lipophilic toxicants in fish species, the higher storage of dioxins in sheep vs. cattle liver (EFSA, 2011)

Contaminants can also interface with infections

a number of bioaccumulating substances (eg dioxins, PFAS, see *EFSA opinions*) can impair the immune responses, including to vaccines
more research needed to assess the impact in field conditions, yet definitely a OH issue

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THREE CASE STUDIES

- impact of climate changes on the assessment of pesticide residues

- trace elements in feeds and the environment

- environmental risks in the animal farm.

CLIMATE CHANGES AND PESTICIDE RESIDUES

Pesticide treatment lead unavoidably to Residues on plants *as well as* secondary exposure of food chains through water and soil and of livestock through crops used as feeds (or fodder)

Climate components influence the whole combination of abiotic, biotic and agronomic parameters = regulation of pesticides requires building-up realistic worst-case scenarios.

Climate-induced changes of
A) environmental and agronomic parameters *(eg plant diseases)*=
amount/duration of pesticide exposure
and its environmental diffusion (eg groundwater)
B) biotic (plant microbiome)
and abiotic factors (temperature...)
= quali-quantitative effect on
substance-specific residue patterns

because -indeed- one main question is...

WHAT RESIDUES?

(Establishment of the residue definition for dietary risk assessment: EFSA 2016)

Residues often do *not* coincide with the parent substance

(azole fungicide Epoxyconazole: *68 metabolites identified,* some can be more reactive than parent substance)

- quali-quantitative *characterization (amount and toxicity) of residues* in the appropriate environmental scenarios is all-important

- Transformation processes might produce a high-concern metabolite (eg, genotoxic) from a low concern substance

  - ***high temperature and humidity* increase the formation of the highly toxic (and thyroid-disrupting) metabolite ETU from widely used dithiocarbamate fungicides (Mancozeb, etc.)**

Therefore, climate changes may modify exposure of ecosystems, farm animals and humans to pesticide residues by modifying

Pesticide usage patterns

Abiotic/biotic factors making-up residue patterns

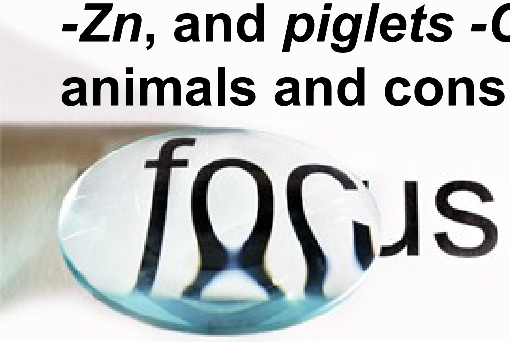
Risk assessment scenarios may need *substantial updates* to account for climate changes

From the FARM to the ENVIRONMENT

Feeds can be a source of substances that may present risks for the ecosystems, due to their toxicity and presence in animal excreta *(eg, EFSA opinions on coccidiostats, supplemental copper or zinc)* and even lead to secondary contamination of food chains (high Cu in the environment = toxicity for ruminants).

Factors like soil pH, distribution and dynamics of run-off waters presence and distribution of soil/water biota make-up the parameters for environmental risk assessment scenarios

Zinc and Copper are essential trace elements extensively added to feed as nutritional supplements Maximum legal levels satisfied animal requirements (highest in *veals -Zn*, and *piglets -Cu*) and were of *no concern* for toxicity in farm animals and consumers



BUT of concern for the environment al biota

Concerns and OH approach (EFSA 2014 on Zn; 2016 on Cu)

From animal excreta to living organisms in soils and surface waters
Highest exposures: Intensive farming, use of feces as manure
Risks at *legally authorized levels*:
long term toxicity for *aquatic biota* (*Zn*- exp. acidic soils)
Bioaccumulation and toxicity for *biota in sediments* (*Cu*)

Data-based assessment: multiple up-to-date information sources on
1) requirements (species and lifestages)
2) how much Cu and Zn are "naturally" in feeds and feed ingredients
(= how much supplementation is *really needed*)
3) how much Cu and Zn are bioavailable / and are excreted
when assumed from (a) supplements and (b) feed ingredients
how far Zn and Cu can be reduced without risks for animal health
New and lower maximum levels are proposed (and adopted by EU)
leading to Cu/Zn emissions estimated - 20-30%

Using knowledge on animal nutrition to
reduce environmental risks
= OH

Environmental pollution goes to farm

Among so many cases, the Sacco river valley:
a thriving farming area south to Roma, alert starting from 2005
- Long-term leaching from industrial waste of Beta-HCH,
a by-product of production of the (*now banned*) insecticide *lindane*
- Beta-HCH is *poorly studied* (a *old by-product*!) but is
persistent, fat-soluble and endocrine disruptor (estrogenic activity)
***No up-to-date toxicological limits*, health concerns!**
- Persistent, poorly water-soluble, highly fat-soluble =
continuous leaching gets to river sediments
The river *overflows periodically*, sediment gets to the fields
- Bioaccumulating, fat-soluble = long-living dairy farm animals (a thriving activity in the area) most vulnerable
- Milk contamination (detected at *routine controls*) as the flag:
levels *20-fold* the maximum legal limits!
- Pollution of farms parallels the use of contaminated fodder

Modelling probability spatial maps of dairy farm exposure as marker of overall b-HCH pollution (*Battisti et al, 2013*) = A possible OH model

Environmental risks in the dairy farm: a framework

(*Lombardo et al., 2017*)

Risk assessment of environmental risk factors at farm level can be supported by the *structured analysis* of Points of Particular Attention

- Farm position and the surrounding area:
geo-climatic factors, neighbouring waste disposal sites,, *previous alerts*, land usage, main crops, hydro-geographic network (*nitrate*?)

- Farm size and conditions, including biosecurity, and prevention tools use of *biocides*? mass use of *drugs*?

- Animal nutrition: feed quality and *origin*

- Use of pesticides: potential for fodder/litter/water pollution ?

- Results from routine and ad hoc controls

Risk maps can be used to
Derive decision trees for risk management
Support OH field epidemiological studies

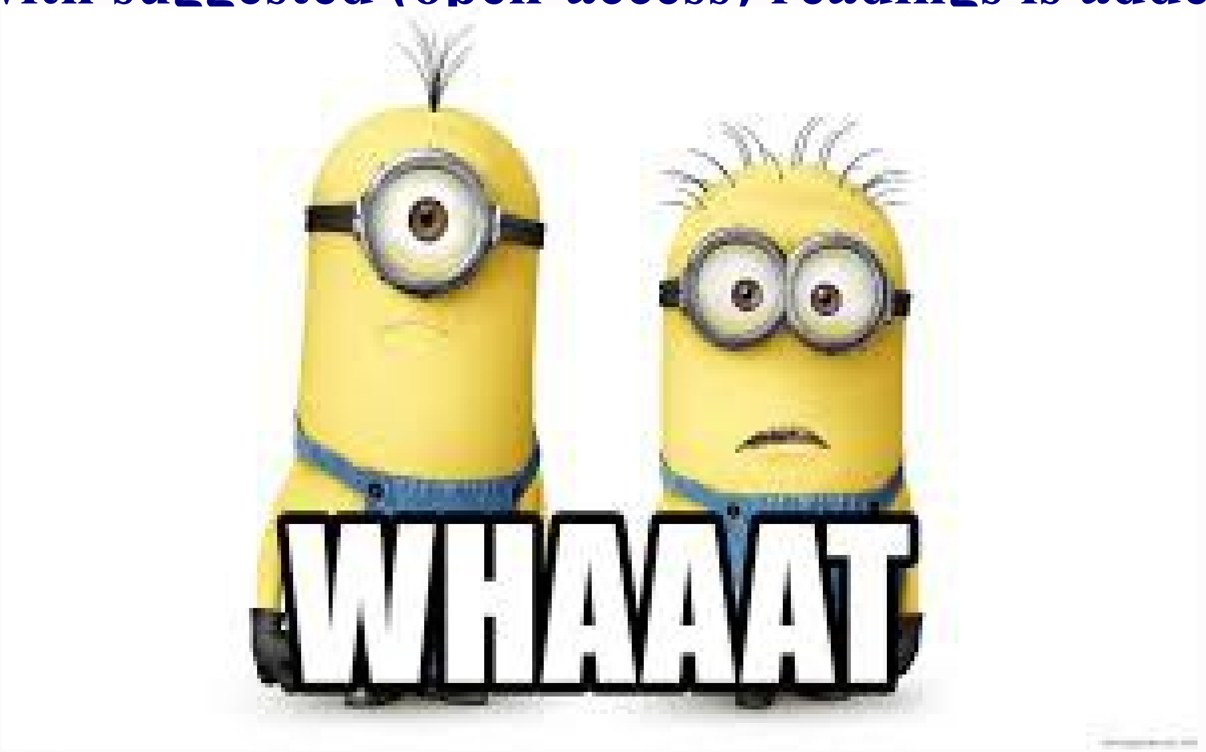
In conclusion

Environment (including climate changes) frames the risks (exposure as well as hazards in several cases) of OH-relevant factors
Risk assessors and risk managers should identify priority targets and if needed "*protection goals*"(EFSA 2016) in order not to
drown into complexity

The agri-food system is part of the environment and can detrimentally affect it: OH-targeted risk assessment should integrate considerations of *food security and sustainability*
= Risk-to-Benefit assessment of possible options

Environmental toxicants are a OH issue as they can affect food-producing animals and human health in several ways, including reduced immune capacity
OH-field epidemiology on environmental toxicants is needed

P.S. A file with suggested (open-access) readings is added !



Thank You for patient listening!