Food and Agriculture Organization of the United Nations

FMM/RAS/298: Strengthening capacities, policies and national action plans on prudent and responsible use of antimicrobials in fisheries

ANTIMICROBIAL USAGE IN AQUACULTURE

Review of AMU in aquaculture based on 1996 and 2009 FAO surveys on the use of chemicals and veterinary drugs in aquaculture and other more recent literature

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Aquatic AMR Workshop 1: 10-11 April 2017, Mangalore, India

Published Surveys in Scientific Literature

- Primavera, J.H., Lavilla-Pitogo, C.R., Ladja, J.M., Dela Pena, M.R. 1993. A survey of chemicals and biological products used in intensive shrimp farms in the Philippines. Marine Pollution Bulletin 26, 35–40.
  - conducted face to face interview with set of questionnaires
  - antibiotics that were found being used in prawn farms and available in the market were oxytetracycline, chloramphenicol, erythromycin, nitrofurans, oxolinic, and sulfa drugs
- Graslund, S, Holmstrom K. and Wahlstrom A. 2003. A field survey of chemicals and biological products used in shrimp farming. Marine Pollution Bulletin 46:81-90 (**conducted Thailand**)
  - conducted face to face interview with set of questionnaires
  - at least 13 different kinds of antibiotics was documented. The most commonly used group was fluoroquinolones, followed by tetracyclines and sulfonamides.

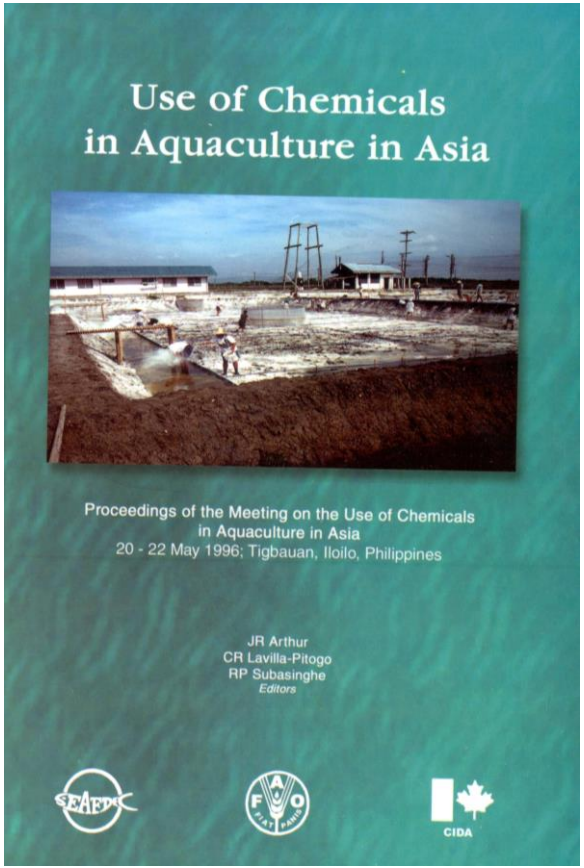
Published Survey in Scientific Literature (2013)

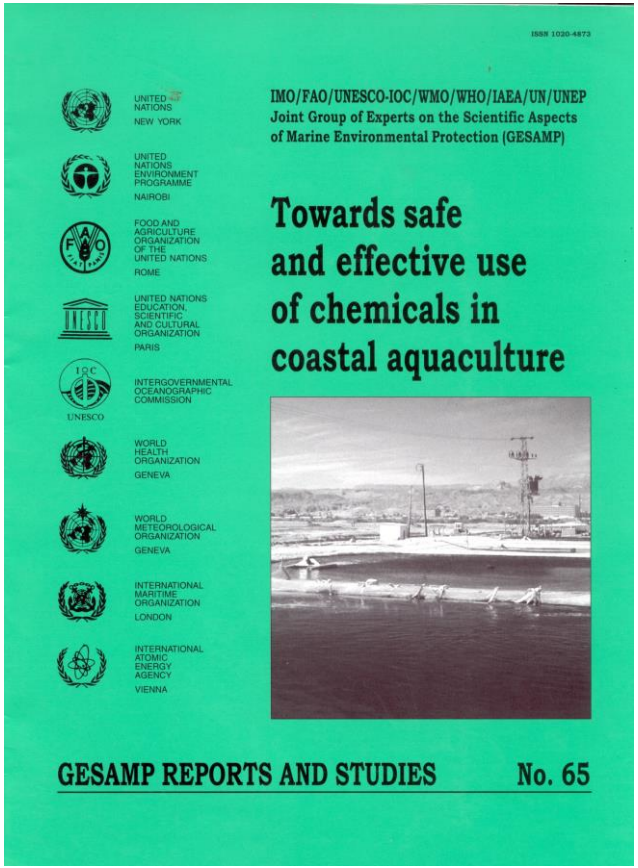
Rico *et al.* 2013. Use of veterinary medicines, feed additives and probiotics in four major internationally traded aquaculture species farmed in Asia. Aquaculture 412-413:231 – 243

- Conducted in Bangladesh, **China**, Thailand and **Vietnam** for Macrobrachium, penaeid shrimps, tilapia and Pangasius catfish farms
- Methodology: Structured interviews with farm owners, managers or technicians of 252 farms
- 60 different veterinary medicinal ingredients (**26 are antibiotics**)
- Highest usage of antibiotics was in the Pangasius farms, but the total quantities of antibiotics applied, relative to production, were **comparable or lower than those reported for other animal production commodities**. = Is this a cause for concern?
- Culture intensity influenced chemical use pattern
  - "chemicals" did not give a break down on whether they were antibiotics, probiotics, disinfectants, etc.

FAO 1996

AQUACHEM and GESAMP meeting reports





AQUACHEM

Use of Chemicals in Aquaculture in Asia (FAO, SEAFDEC, CIDA)

- May 1996
- 16 countries, at least 15 experts
- 17 presentations
- Country papers were based on face to face surveys and/or questionnaires

Summary of usage of antibiotics/antimicrobials/antibacterials

Country	Commodity/ Facility	Antimicrobials	Relevant References
Bangladesh	Carp	OTC in less than 5% of farms	Phillips 2000; Chowdhury & Inglis 1994
	Shrimp	OTC, chloramphenicol, oxolinic acid	
Cambodia	Carp	OTC	Phillips 2000
	Shrimp	OTC	
China	Not specified	Terramycin, furazolidone, sulphonamide, aureomycin, penicillin, streptomycin, doxycycline, erythromycin, chloramphenicol, oxolinic acid	Yulin 2000
India	Freshwater systems (carp)	OTC, chloramphenicol other antibiotics	Pathak, Gosh and Palanisamy 2000
	Shrimp	OTC, chloramphenicol, other antibiotics	
Indonesia	Fish and shrimp (species not specified)	OTC, chloramphenicol, Erythromycin, Streptomyin, Prefuran, Enrofloxacin, Neomycin	Supriyadi and Rukyani, 2000
Japan	Yellowtail	22 drugs (Table 2)	Wilder, 2000
	Rainbow trout	7 drugs (Table 2)	
	Kuruma prawn	OTC and oxolinic acid	

AQUACHEM

Use of Chemicals in Aquaculture in Asia (FAO, SEAFDEC, CIDA)

Problems identified

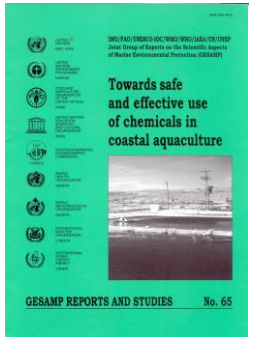
- Residues in fish; food safety
- Fate and persistence in the environment
- Development of AMR
- Weak implementation of regulations on sales and usage
- Lack of alternatives to antibiotics

Recommendations

- Farmers, producers and suppliers
- Government and organizations
- Research sector

Lao PDR	Limited to lime and fertilizers in freshwater systems	None reported	Phillips, 2000
Malaysia and Singapore	Shrimp and marine fish	Sulfonamides, Tetracyclines, Nitrofurans, Chloramphenicol, oxolinic acid, Virginiamycin, Dimetridazole, Metronidazole	Shariff, Nagaraj, Chua & Wang, 2000
Nepal	Carp (EUS)	None reported	Phillips, 2000
Pakistan	Carp	Unknown antimicrobials?	Phillips, 2000
Philippines	*Penaeus monodon* hatcheries	OTC, Rifampicin, Bactrin Forte, Chloramphenicol, Furazolidone, Prefuran, Erythromycin	Lacierda, de la Pena & Lumanlan-Mayo, 2000
	P. monodon ponds	OTC, Chloramphenicol, oxolinic acid, Furazolidone	
Sri Lanka	Shrimp broodstock	OTC, Furazan, furazolidone, Erthromycin	Wijegoonawardena & Siriwardena, 2000
	Shrimp larvae	OTC, Chloramphenicol, Erythromycin, Furans	
Taiwan	Not specified	12 antibiotics	Liao, Guo & Su, 2000
Thailand	Freshwater and marine species	OTC, Erythromycin, oxolinic acid, nitrofurans, sulphamonomethoxine	Tonguthai, 2000
Vietnam	Carp	Unspecified antibiotics	Phillips, 2000
	Shrimp	OTC and “other” antibiotics	

GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection



PREPARATION OF THIS STUDY

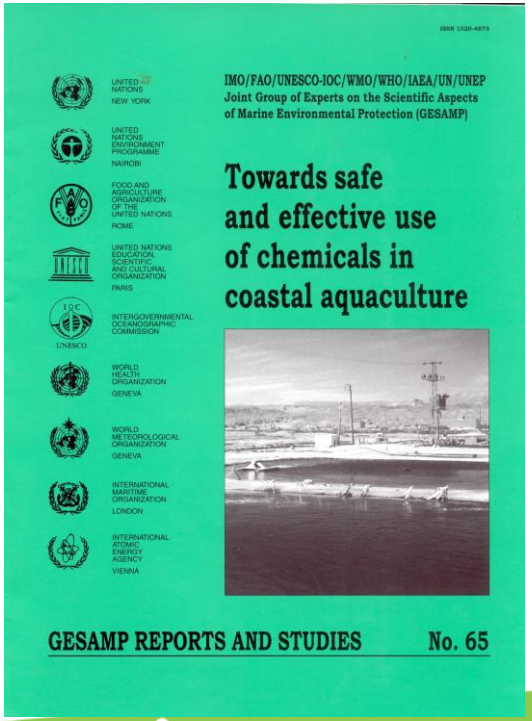
This study has been prepared on the basis of the work of the GESAMP Working Group on Environmental Impacts of Coastal Aquaculture.

The Working Group met in Iloilo, Philippines, 22 - 28 May 1996. Its report was reviewed by the 27th session of GESAMP, Nairobi, 14 - 18 April 1997, and subsequently approved for publication in its present form.

The Working Group session was attended by the following experts: David J. Aldermann, Uwe Barg (Technical Secretary), Mali Boonyaratpalin, Erlinda Cruz-Lacierda, Valerie Inglis, Celia Lavilla-Pitogo and Ewen MacLean, Jurgene Primavera, Donald P. Weston (chair). A study was contributed by P. Sinhaseni, Malinee Limpoka and Ornrat Samitawat.

The intersessional work of the Working Group was jointly sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP) and the World Health Organization (WHO). The Secretariat was provided by FAO.

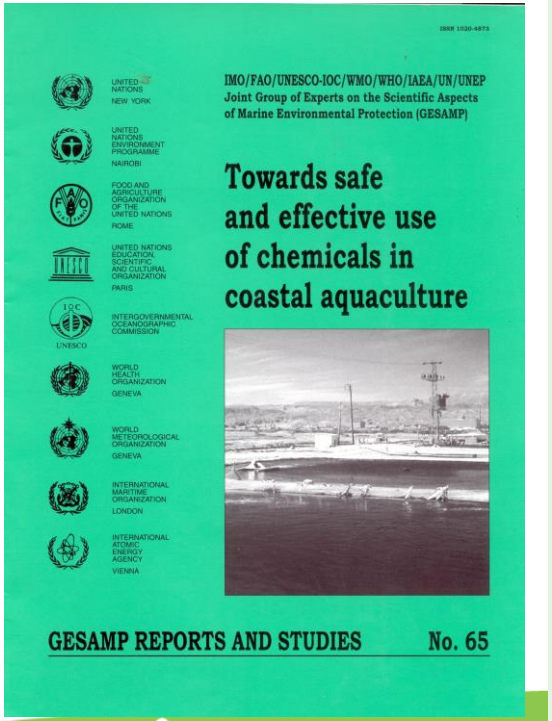
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection



Section 2.5 of report: Antibacterial Agents

- β-***lactams*** - benzyl penicillin, amoxycillin; not effective against vibriosis and motile aeromonads. The β-lactams are important in human medicine.
- ***Nitrofurans*** - group of synthetic antibacterials including furazolidone and nifurpirinol; potentially carcinogenic. This has led to their prohibition for use on food animals.
- ***Macrolides -*** The only macrolide used in fish farming is erythromycin. It is active against Gram-positive bacteria, but used in shrimp hatcheries in Southeast Asia.
- ***"Phenicols"*** - very broad-spectrum antibiotics including chloramphenicol, thiamphenicol, and florphenicol; important in human medicine as the treatment of typhoid. The major environmental hazard of chloramphenicol is its potential to increase drug resistance. Derivatives have been developed for veterinary use.

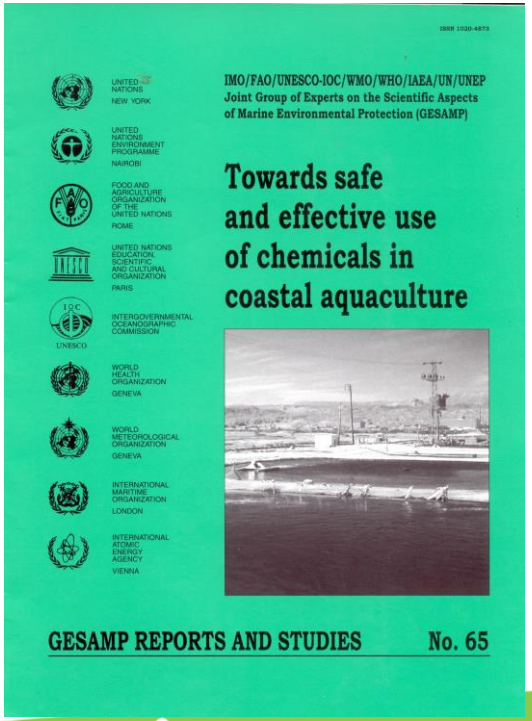
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection



Section 2.5 of report: Antibacterial Agents (continuation)

- ***4-Quinolones*** **-** synthetic antibacterial agents that include nalidixic acid, oxolinic acid and flumequine. The second generation of more potent fluorinated derivatives includes enrofloxacin and sarafloxacin.
- ***Rifampicin*** - Limited use of this antibacterial has been reported for treatment of luminous vibriosis in shrimp culture in parts of Southeast Asia (Primavera, 1993).
- ***Sulphonamides*** **-** may be used alone but commonly used when potentiated with trimethoprim or ormetoprim. Romet® 30 is an example and one of only two aquaculture antibacterials licensed in the USA. Other preparations are Tribrissen and Co-trimoxazole.
- ***Tetracyclines*** **–** oxytetracycline (OTC), chlortetracycline, doxycycline. OTC is probably the most widely used antibiotic in aquaculture; effective against a wide variety of Gram-negative and Gram-positive bacteria.

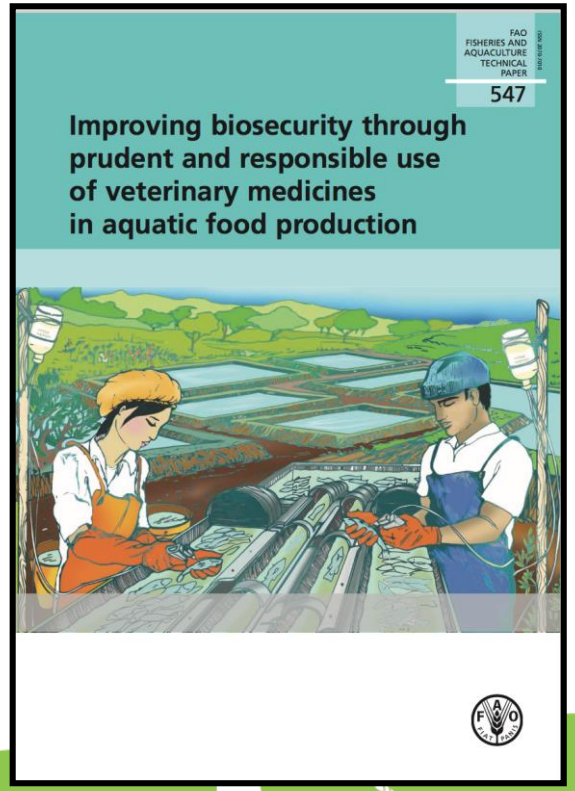
GESAMP – Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection



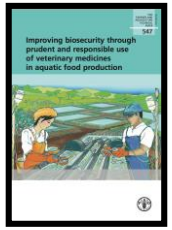
Section 3 of report: Issues of Concern

- **Persistence**
- **Residues in non-cultured organisms and in seafood**
- **Toxicity to non-target species**
- **Stimulation of resistance**
- **Health of farm workers**
- **Prophylactic use of antibiotics**
- **Quality assurance of chemicals used in aquaculture**
- **Need for data on quantities used**
- **Need for environmental fate and effects information**
- **Need for alternatives**

FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production



- Bondad-Reantaso, Arthur & Subasinghe, editors. 2012
- Outcome of FAO/AAHRI workshop in Bangkok (2009)
- 15 papers
  - Survey on the use of veterinary medicines in aquaculture
  - Country status presentations
    - **China**
    - **Philippines = same participants today ☺**
    - Thailand
    - **Vietnam**
- Workshop Outcomes



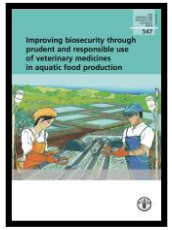
FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

Alday-Sanz, Corsin, Irde & Bondad-Reantaso, 2012

Survey structure and process

A survey questionnaire was developed with seven sections, briefly described below

- Section 1: Respondent profile (academic background and professional activity of the respondent)
- Section 2: Types of antimicrobials used for therapeutic purposes (antimicrobials used for treating disease (therapeutic application) in different host species groups)
- Section 3: Types of antimicrobials used for prophylactic purposes (antimicrobials used for prevention of diseases (prophylactic application) and the stages when they are applied (broodstock, hatchery and grow out).
- Section 4: Application (percentage at the different stages of culture (broodstock, hatchery and grow out) and dosage and duration of antimicrobial treatments for prophylactic and therapeutic use)
- Section 5: Use of chemotherapeutants (type, mode of application and for which diseases, source and availability), as well as other veterinary products (i.e. anesthetics, sex control aids, spawning aids, etc.) used in aquaculture
- Section 6: Impact (perceived positive and negative impacts) and efficacy (possible reasons for failure)
- Section 7: Recommendations for actions to improve effectiveness and responsible use in aquaculture

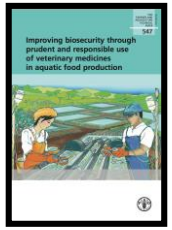


FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

Alday-Sanz, Corsin, Irde & Bondad-Reantaso, 2012

- Sent questionnaires to global contacts by email
- Organized in-country workshops participated in by industry stakeholders (farmers, feed millers, drug suppliers, retailers, etc.)
- Visited stores, farms and feed mills

Above information feed into the Bangkok 1999 meetings and were discussed in the workshop

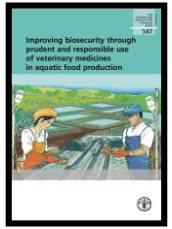


FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

Alday-Sanz, Corsin, Irde & Bondad-Reantaso, 2012

FINDINGS:

- More treatment than prevention was the management strategy
- Oxytetracycline was the most reported product for treatment and prevention
- Commonly perceived reason for treatment failure were WRONG DIAGNOSIS
- There are very few approved drugs for aquaculture
- A way to reduce use of veterinary medicines is through training of farmers and fish health advisors on:
  - Health management and biosecurity
  - Diagnostics
  - Proper use of veterinary drugs

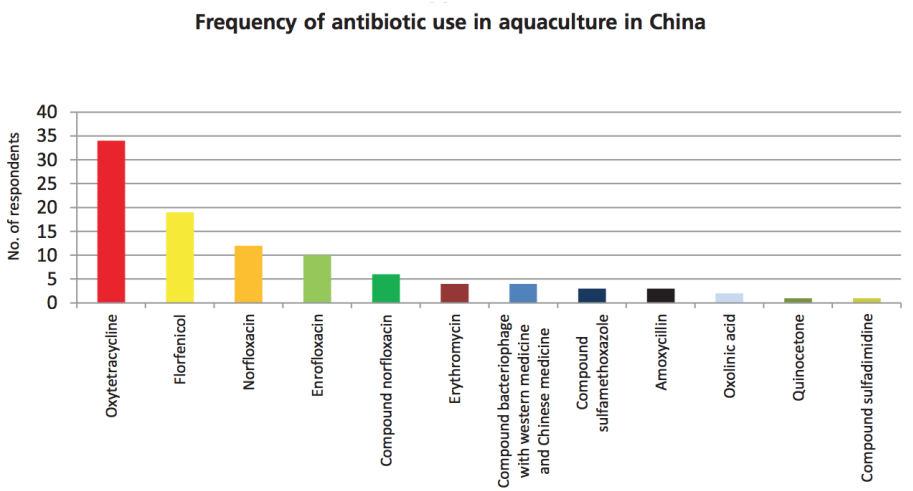


FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

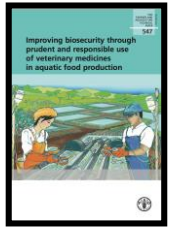
CHINA: Yuan and Chen, 2012

Antimicrobial agents used in Chinese aquaculture

Antibiotic	Target pathogen or disease	Dosage and application
Oxytetracycline	Enteritis, bacterial disease	4 ‰ in fish feed for 3–5 days or 2–10 mg/kg fish weight for 3–7 days
Norfloxacin	Bacterial disease	Prevention: 100 g/80–100 kg feed, 1 time per day for 3–5 days; Treatment: 100 g/50–60 kg feed, 2 times per day for 5–7 days
Enrofloxacin	Bacterial disease	Treatment: 200 g/80 kg feed
Florfenicol	Broad spectrum antibiotic, bacterial infection	10–15 mg/kg fish weight for 3–5 days, once per day; 0.5 ppm for 3 days
Compound bacteriophage with western medicine and Chinese medicine	Bacterial, fungal and viral infections	1–2.5 g/kg feed for 3–5 days
Compound Norfloxaci	Bacterial infection, Mycoplasma infection	20 g/kg feed for 3 days, once per day
Quinocetone	Gastrointestinal diseases	40–50 ppm
Compound sulfamethoxazole	Bacterial infection	2–3 mg/kg fish weight for 3–5 days
Compound sulfadimidine	Redfin disease, red skin disease, lepidorthosis, enteritis, etc.	1.5 g/kg fish weight for 6 days, twice per day
Erythromycin	White head-mouth disease, gill rot disease, etc.	0.5 g/100 kg fish weight for 6 days; 1 ppm for 5 days
Amoxycillin	Infectious diseases of fish	0.2 ppm for 5 days
Oxolinic acid	Redfin, red skin disease, etc.	10–20 mg/kg fish weight for 4–7 days
Ivermectin	Parasites	Treatment: 20–30 ml/mu fish pond
Abamectin	Parasites	Treatment: 20–30 ml/mu fish pond



PHILIPPINES: Somga, Somga & Regidor, 2012



FAO 2009 – Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

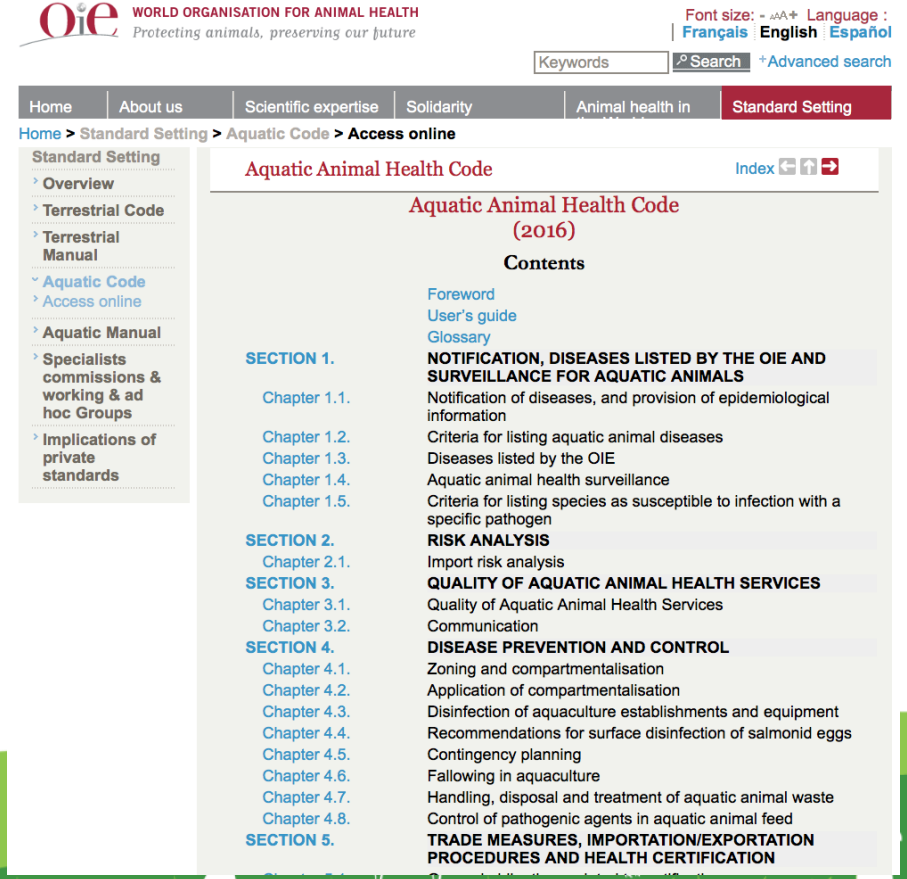
Viet Nam: Mai, 2012

- Report is based on surveys in 2003 – 2004
- Information is based on consultative workshops with stakeholders
- Info also gathered by desktop review

- Results showed 223 antibiotics
  - Mostly imported
  - 62% of imported veterinary drugs were from Thailand

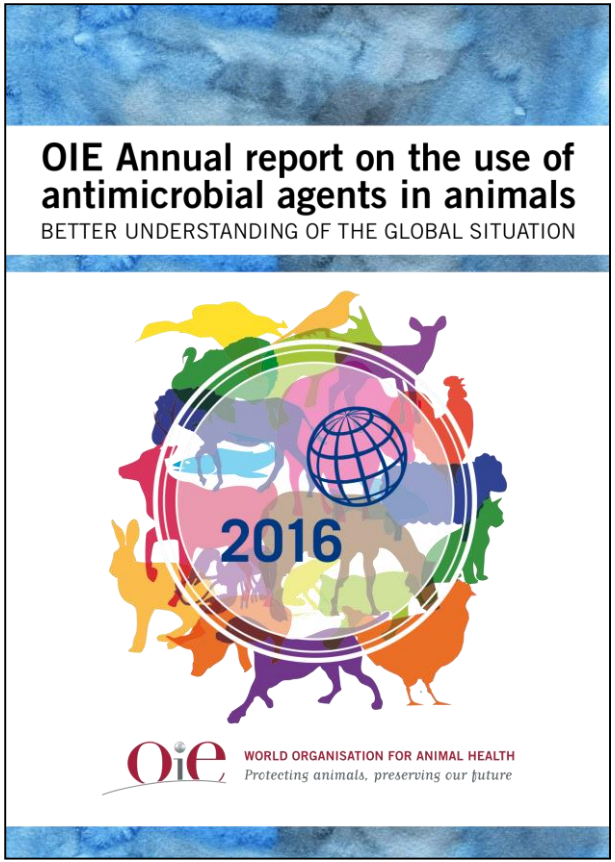
OIE Aquatic Manual

Section 6: Antimicrobial use in aquatic animals (2010-2013)



OIE Survey

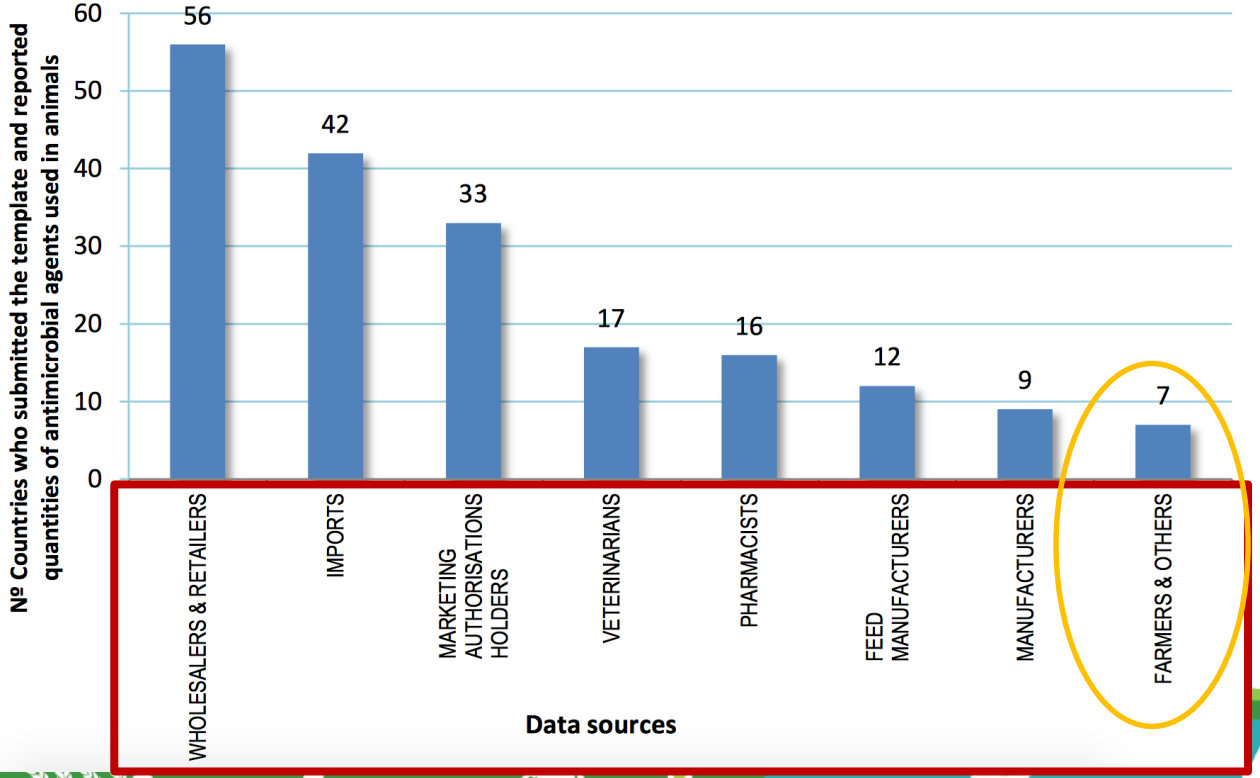
2016



- Templates used in the survey are in http://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/Survey_on_monitoring_antimicrobial_agents_Dec2016.pdf

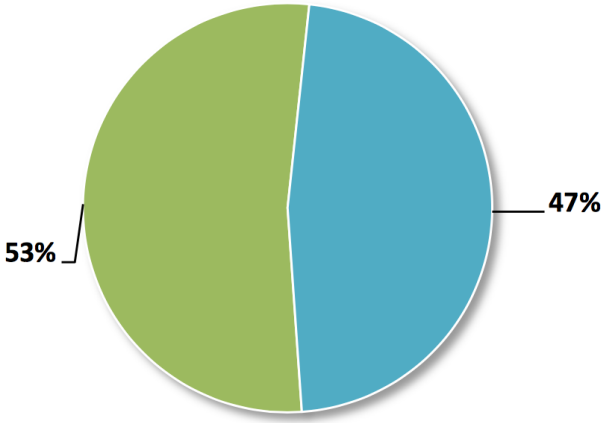
OIE Survey – Data Sources

Figure 7. Data source as reported by 89 Member Countries, 2010-2015



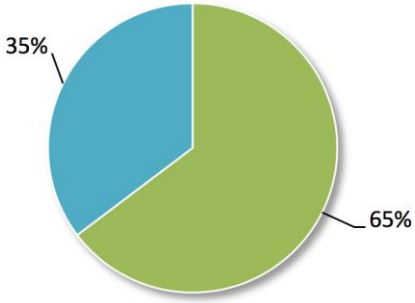
OIE Survey – No Differentiation of Data by Animal Groups

. Differentiation of the data reported by animal groups in 89 Member Countries, 2010-2015



No differentiation between animal groups Differentiation by animal groups

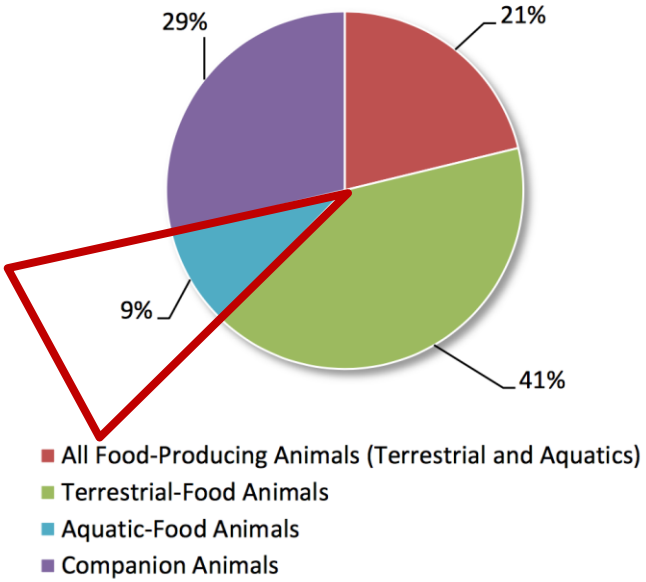
Figure 29. Animal groups covered by the data in 17 Asian Member Countries



No differentiation between animal groups Differentiation by animal groups

OIE Survey – Animal Groups

Figure 9. Animal groups reported by 42 Member Countries, 2010-2015



NOTES:

- first year of analysis

- a preliminary finding shows that national monitoring systems on the use of antimicrobial agents in aquatic food-producing animals are implemented only after national monitoring systems on the **use of antimicrobial agents in terrestrial food-producing animals have been implemented** to the highest level of specificity, by route of administration.

OIE Survey – Antimicrobial Classes Reported by 89 Member Countries

Figure 31. Proportion of reported antimicrobials classes by 17 Member Countries in Asia, 2010-2015

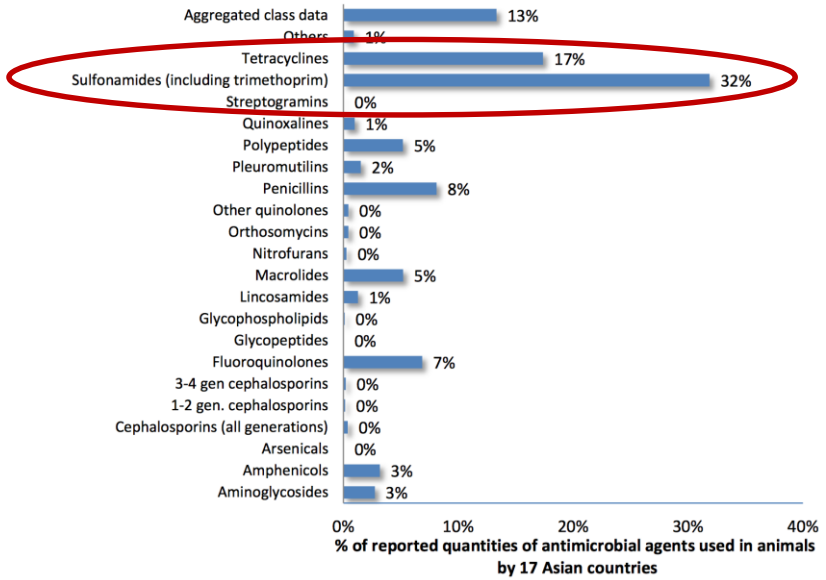
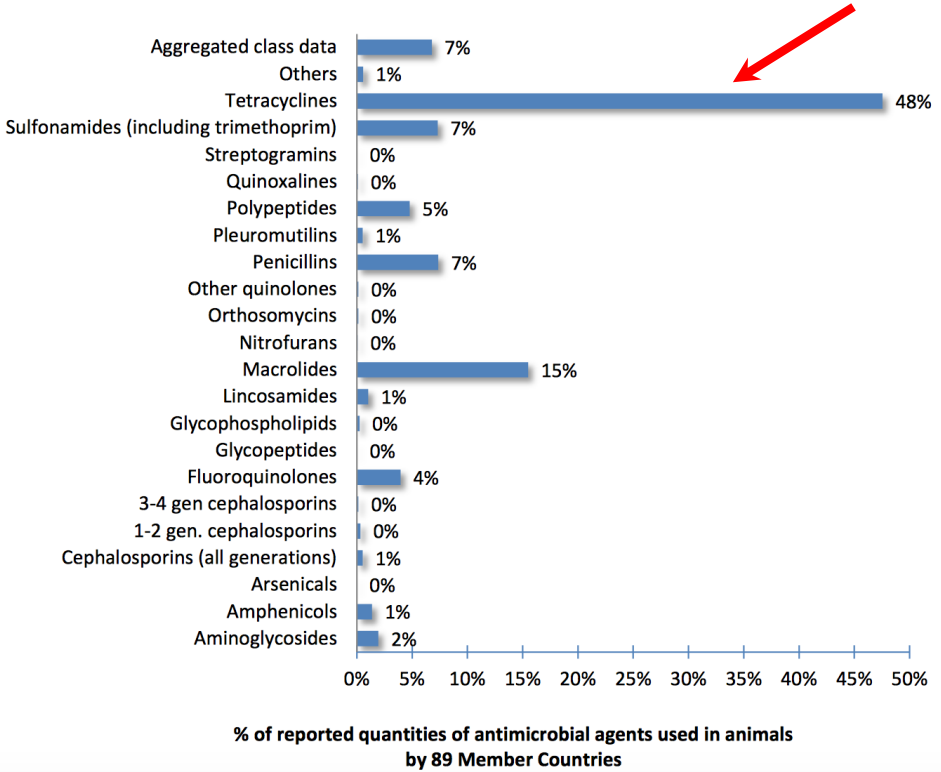
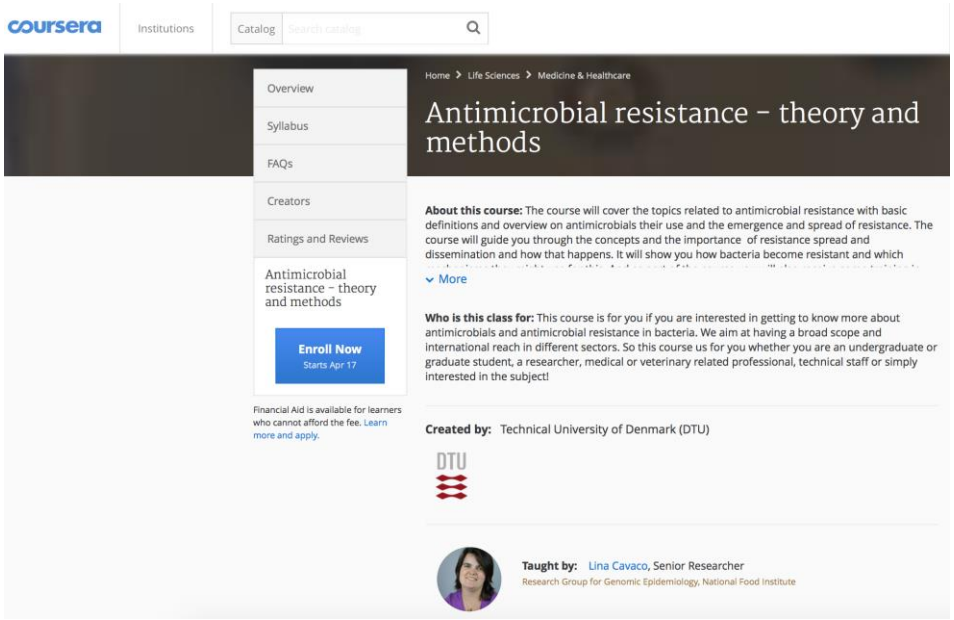


Figure 14. Proportion of reported antimicrobial classes by 89 Member Countries, 2010-2015



OIE Survey – CONCLUSIONS

- The information represents a remarkable first step in better understanding the global use of antimicrobial agents in animals.
- The data reported will become more precise with each passing year with more countries readying to put in place surveillance systems on the use of antimicrobial agents in animals.
- There is a need to provide additional support to Member Countries to improve their national monitoring systems.
- Detailed interpretation of the data also needs further development.
- The OIE database should allow countries to provide their information through an electronic portal.



Coursera Learning Resource: https://www.coursera.org/learn/antimicrobial-resistance

Thank you very much!