Source attribution of Foodborne Diseases using Structured Expert Judgement (SEJ)

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WHO Webinar: Source attribution method in the foodborne diseases estimates

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Global source attribution study team*

- Tina Nane (TU Delft)
- Tine Hald (DTU)
- Roger Cooke (Resources for the Future, TU Delft)
- Willy Aspinall (Aspinall&Associates)

- Research assistants from TU Delft
  - Bodille Blomaard, Alessandra Primavera
  - Femke Schurmann, Tyren Koning
  - Floor Jacobs, Vangelis Nakos
  - Si-Jing Chen, Judith Capel

WHO selected our team after the competitive bidding process. https://cdn.who.int/media/docs/default-source/foodborne-diseases/ferg/ferg-satf-001-tor.pdf?sfvrsn=3ade1f0f_3

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Expert judgment methods

Combination of experts' assessments

- Behavioral aggregation techniques
  - Sheffield
- Mathematical aggregation techniques
  - Bayesian methods
  - Equal weighting aggregation
  - Un-equal weighting aggregation (Classical Model)
- Mixed techniques
  - Delphi
  - IDEA

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The Classical Model for Structured Expert Judgment

- **Experts in Uncertainty (Cooke, 1991)**
  - Cooke Method
  - Delft Method
  - The Classical Model for Structured Expert Judgment

- Numerous applications
  - Climate change
  - Nuclear applications
  - Chemical & gas industry
  - Ground water, water pollution, dikes, barriers
  - Epidemiology
  - Natural disasters and extreme events
  - Aerospace sector, space debris, aviation
  - Volcanoes, dams

World Health Organization
NASA
AIRBUS
TNO
NLR
KLM
BILL & MELINDA GATES foundation
efsa European Food Safety Authority
CDC Centers for Disease Control and Prevention
esa
RIVM
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Classical Model for Structured Expert Judgment

Overconfidence

Target questions: attribution estimates

Hazards:
- 25 enterics
- 10 parasites
- 6 chemicals

- 7 transmission pathways
- 14 specific food categories
- 17 cluster of countries (sub-regions)

Model:
- Multiple experts
- Mathematical combination of experts' assessments
- Uncertainty quantification

Calibration questions:
- tailored to hazard/regional expertise

Weights for mathematical aggregation of the target questions assessments

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Cooke's Classical Model

- Considerations for the choice of method
  - Expert data is scientific data (empirical control)
  - Validated aggregation to calibrate the mathematical model
  - Transparent, reproducible and defensible

- Practical considerations
  - Gathering experts not possible
  - Face-to-face interviews not possible
  - Multidisciplinary panel
  - Interviews conducted in different languages

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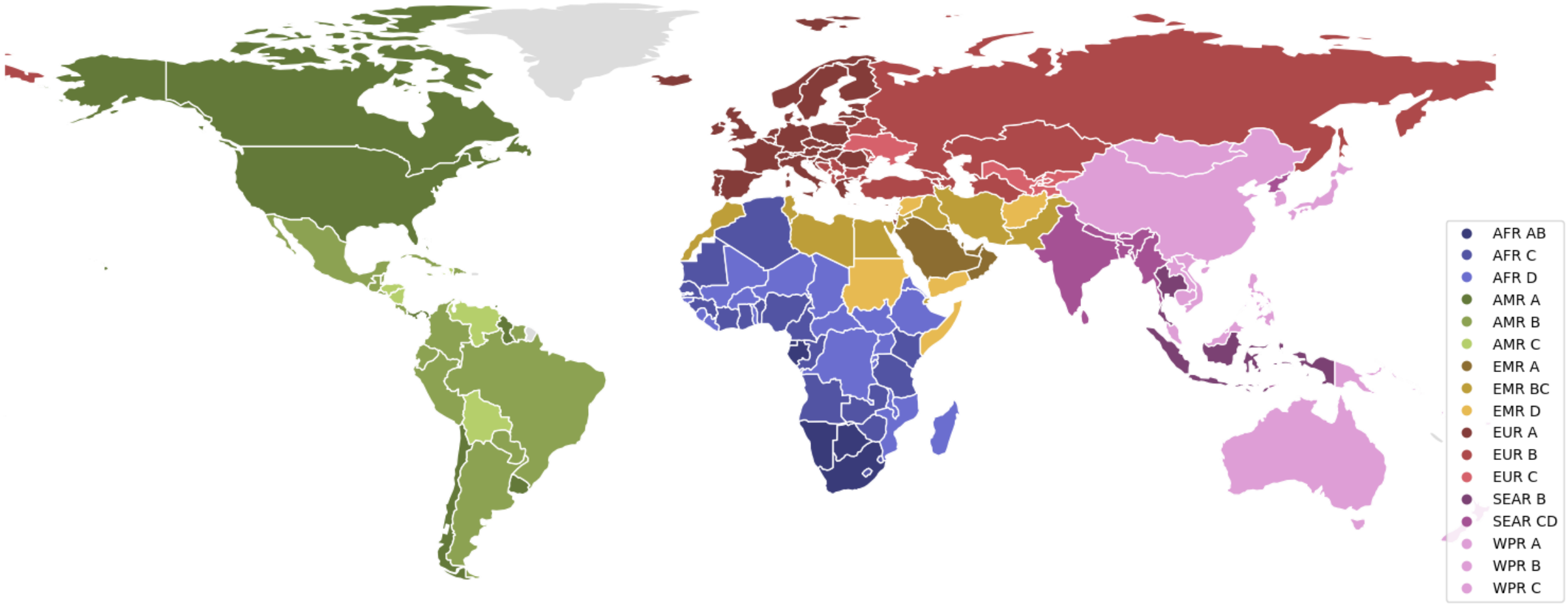
Hazards

Enteric diseases (diarrheal diseases) 14	Enteric diseases (non-diarrheal diseases) - 10	Parasitic diseases 10	Chemicals and Toxins 6
Campylobacter spp.	*Brucella* spp.	*Ascaris lumbricoides*	Aflatoxin B1
Cryptosporidium spp.	*Clostridium perfringens*	*Echinococcus multilocularis*	Arsenic
Cyclospora (new)	*Clostridium botulinum*	*Echinococcus granulosus*	Cadmium
Entamoeba histolytica	Hepatitis A virus	*Fasciola* spp.& *Fasciolopsis*	Dioxin
Enteroaggregative *E.coli*	Hepatitis E virus	*Toxoplasma*	Lead
Enteropathogenic *E.coli*	*Listeria monocytogenes*	*Trichinella*	Methylmercury
Enterotoxigenic *E.coli*	*Mycobacterium bovis/caprae/orygis*	*Trypanosoma cruzi*	
Giardia spp.	*Salmonella* Paratyphi A	*Toxocara*	
Norovirus	*Salmonella* Typhi	*Angiostrongylus*	
Rotavirus	Bacterial toxins: *Staph. aureus*	*Sarcocystis*	
Non-typhoidal *Salmonella enterica*			
Shigella spp.			
Shiga toxin-producing *E.coli*			
Vibrio cholerae			

17 cluster of countries



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Target questions

- For each biological hazard (n=35) and cluster of countries (n=17), estimate the proportion of disease that is transmitted through different pathways

Lower uncertain (5th percentile)	Best estimate (50th percentile)	Upper uncertain (95th percentile)

Target questions

- Estimate the proportion of disease that is transmitted through *water* for Non-typhoidal Salmonella enterica in AFR AB

_____	_____	_____
Lower uncertain bound (5th percentile)	**Best estimate (50th percentile)**	**Upper uncertain bound (95th percentile)**

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Calibration questions

Example questions are from previous study (2015)

Categories of calibration questions for enteric and parasitic hazards

- **Food supply**
  - E.g. Among all sub-regions, in 2010 what was the proportion of regional vegetable supply (tonnes) that was imported rather than produced domestically in the sub-region with the highest such percentage?
- **Health and diarrheal diseases**
- **Improved water and sanitation**
- **Outbreak and disease surveillance**
  - E.g. What will be the rate per 100,000 population of laboratory confirmed human cases of campylobacteriosis in 2012 in all EU member states as reported in EFSA's annual report?

_____	_____	_____
Lower uncertain (5th percentile)	Best estimate (50th percentile)	Upper uncertain (95th percentile)

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Elicitation process

1. Expert selection

- WHO Open call
- Networking (WHO, FERG, snowball effect)

2. Pre-elicitation

- Hazard/regional expertise (Qualtrics link)
- Training module (Qualtrics link)
  - Consent form

3. Elicitation

- Elicitation interview (one-to-one online meeting with a trained elicitor)
  - Cover the calibration questions (tailored to hazard/regional expertise)
  - Go through one hazard

4. Post-elicitation

- Complete all the assessments for all hazards/cluster of countries (2 weeks)
- Fill in a very short feedback survey

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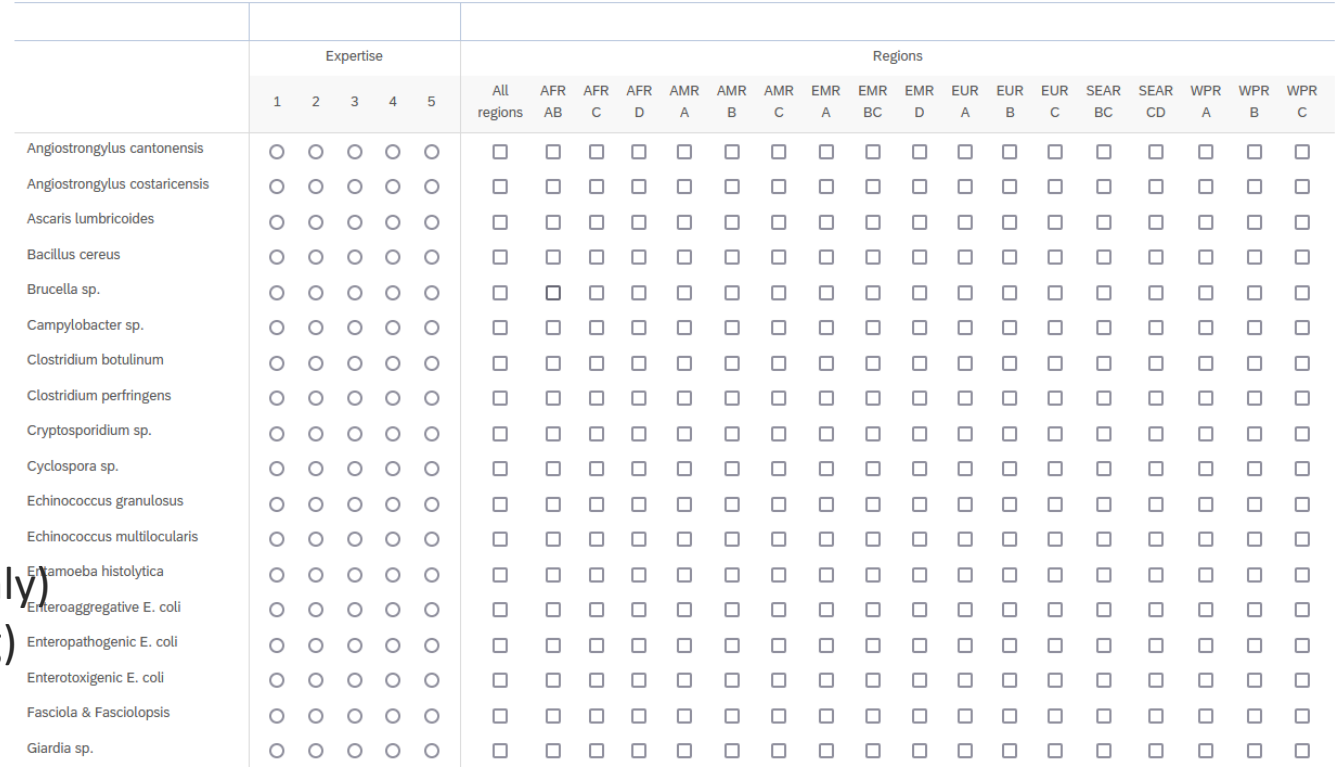
Expert identification and selection

2. Expert selection • Expert selection

- Screening done by WHO Collaborative Centre (**263 recruited experts**)
  - Larger areas of expertise – pathogens, parasites, chemicals
  - Self-reported by experts
  - Check if the information provided in the CV matched the self-reported expertise
- Networking (**108 experts**)
- Additional survey (Qualtrics)
  - Hazard/regional expertise
  - Qualitative expertise level

1 = low (e.g., no direct experience, anecdotal knowledge only)
3 = medium (e.g., some direct experience, but wide reading)
5 = high (e.g., primary focus of my professional work)



	Expertise					Regions																
	1	2	3	4	5	All regions	AFR AB	AFR C	AFR D	AMR A	AMR B	AMR C	EMR A	EMR BC	EMR D	EUR A	EUR B	EUR C	SEAR BC	SEAR CD	WPR A	WPR B	WPR C
Angiostrongylus cantonensis																						
Angiostrongylus costaricensis																						
Ascaris lumbricoides																						
Bacillus cereus																						
Brucella sp.																						
Campylobacter sp.																						
Clostridium botulinum																						
Clostridium perfringens																						
Cryptosporidium sp.																						
Cyclospora sp.																						
Echinococcus granulosus																						
Echinococcus multilocularis																						
Entamoeba histolytica																						
Enteroaggregative E. coli																						
Enteropathogenic E. coli																						
Enterotoxigenic E. coli																						
Fasciola & Fasciolopsis																						
Giardia sp.																						

Training materials

- **Videos**
  - Introduction to the study
  - Introduction to SEJ
  - Uncertainty quantification
    - Practice questions
  - Practical matters about the elicitation
  - Features of the Qualtrics elicitation tool
- **Training questions**
- **Practice exercises**

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Elicitation tool

- Developed in Qualtrics
  - Online tool
  - GDPR compliant
- Tailored for regional expertise

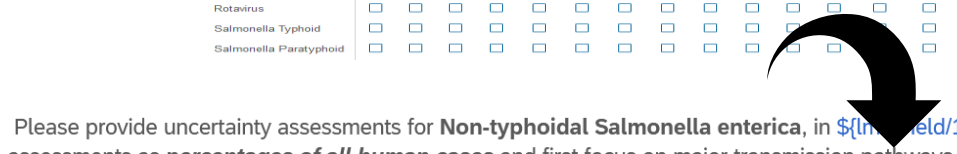
5.Elicitation tool

- Online (Qualtrics)
- Developing and testing
- Translating

For each of the following hazards, and in combination with regions, please indicate your expertise.

The list of countries in all regions is provided below.

	Region																
	AFR AB	AFR C	AFR D	AMR A	AMR B	AMR C	EMR A	EMR BC	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR CD	WPR A	WPR B	WPR C
Staphylococcus aureus	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Clostridium perfringens	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Brucella sp.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Campylobacter sp.	☐	☐	☐	☑	☑	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐
Clostridium botulinum	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cryptosporidium sp.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Cyclospora sp.	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Enteropathogenic E. coli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Enterotoxigenic E. coli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Enteroaggregative E. coli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Giardia sp.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hepatitis A	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hepatitis E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Listeria monocytogenes	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Norovirus	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Rotavirus	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Salmonella Typhoid	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Salmonella Paratyphoid	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐



Please provide uncertainty assessments for **Non-typhoidal Salmonella enterica**, in ${lm://Field/1}. Express your assessments as ***percentages of all human cases*** and first focus on major transmission pathways.

*Think of the source that was the direct cause of human exposure. We are not asking about how the source was contaminated. For more information about the definition used in this study, please check this file.

	Lower credible value (5th percentile)	Central value (50th percentile)	Upper credible value (95th percentile)
Food			
Contact with Animals (Domestic or Wild)			
Human contact			
Water			
Soil			
Other (e.g. airborne/pollution, occupational)			

Great support from elicitors

- Eduard Grau Noguer
- Zoe Baldwin
- Emrecan Özeler
- Emi Grace
- Stephanie Poling
- Ana Margarida Alho
- Uswatun Hasanah
- Selam Alemu
- Jamila Seaton
- Devin LaPolt
- Sarah Hagan
- Maria Olorunsola
- Janet Rymound
- Sara Faife
- Eiki Yamasaki
- Stanley Chen
- Ankur Aggarwal
- Pankaj Dhaka
- Lisa O'Connor
- Maria Francesca Julietto
- Miranda Nonikashvili
- Reha Onur Azizoğlu
- Dikshit Poudel
- Nada Alasiri
- Belisário Moiane
- Dhanalakshmi Marimuthu
- Malak Elbassuny

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Source attribution of foodborne diseases using SEJ

Thank you for your time and attention!

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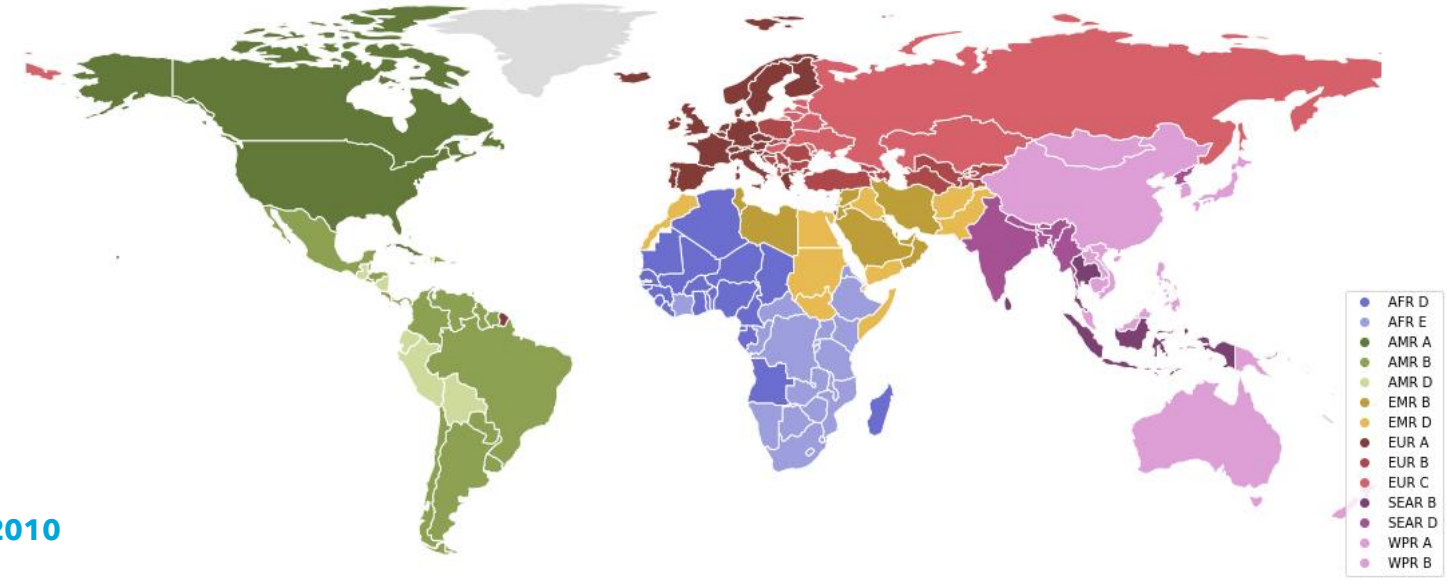
Subregional classification

Old & new classification

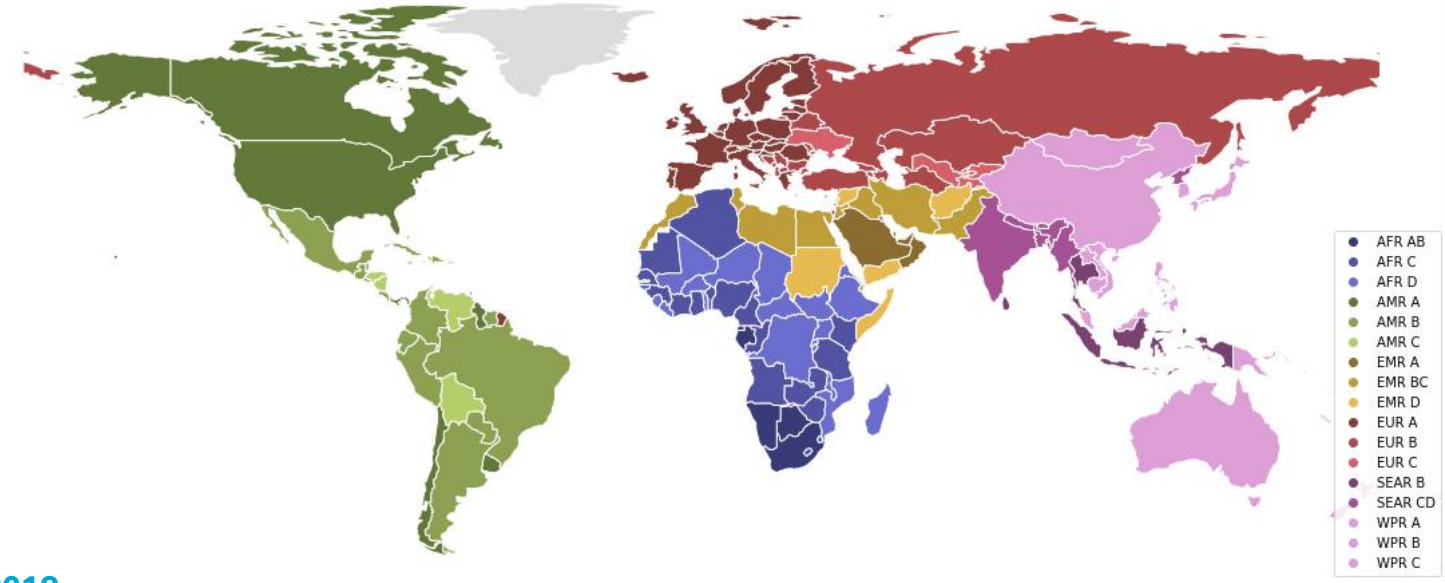
Regions 2010

Regions 2019	AFR D	AFR E	AMR A	AMR B	AMR C	EMR A	EMR BC	EMR D	EUR A	EUR B	EUR C	SEAR B	SEAR CD	WPR A	WPR B
AFR AB	5%	95%													
AFR C	68%	32%													
AFR D	28%	69%					3%								
AMR A			93%	7%											
AMR B			2%	86%	12%										
AMR C				59%	41%										
EMR A						100%									
EMR BC						23%	77%								
EMR D						18%	82%								
EUR A								84%	12%	3%					
EUR B									41%	59%					
EUR C									48%	52%					
SEAR B											100%				
SEAR CD												100%			
WPR A														76%	24%
WPR B															100%
WPR C															100%

Percentage of old regions represented by the new regions (read horizontally) based on population sizes in 2010 (Worldbank)



2010



2019