Mosquito-borne diseases, biodiversity & climate change

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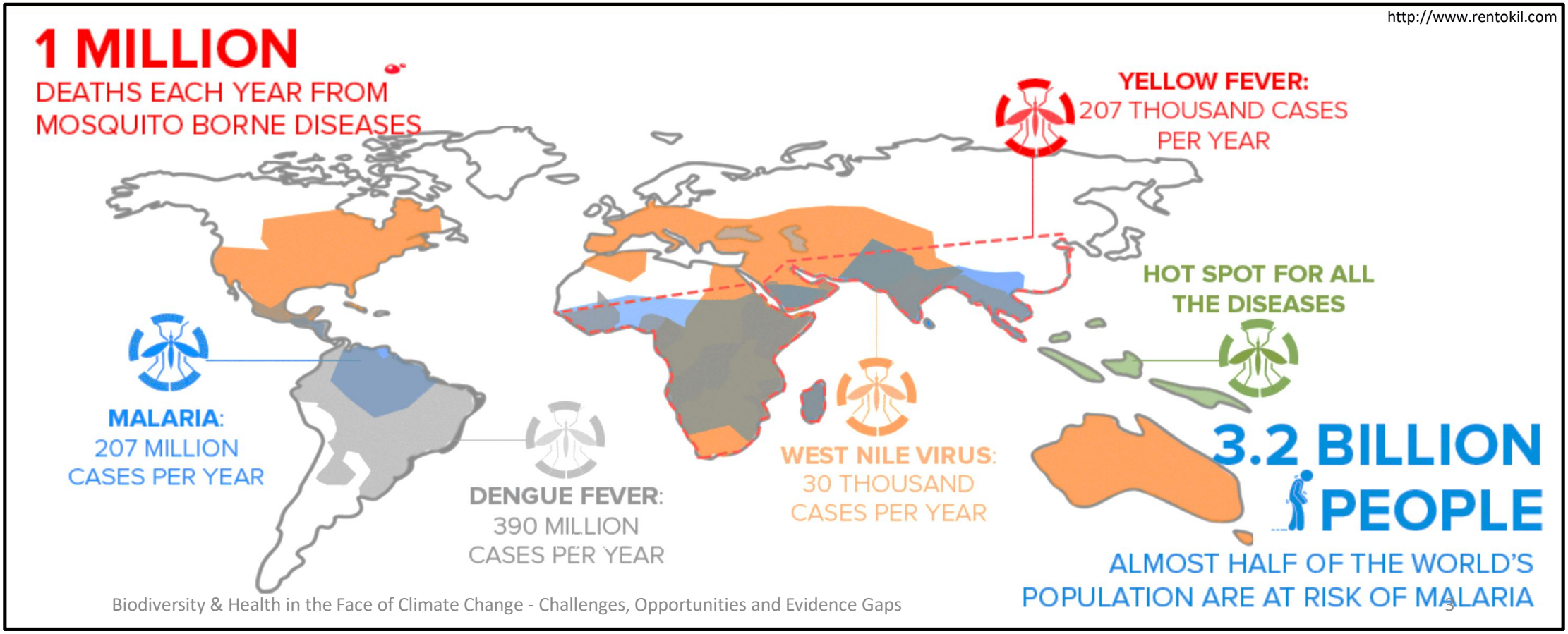
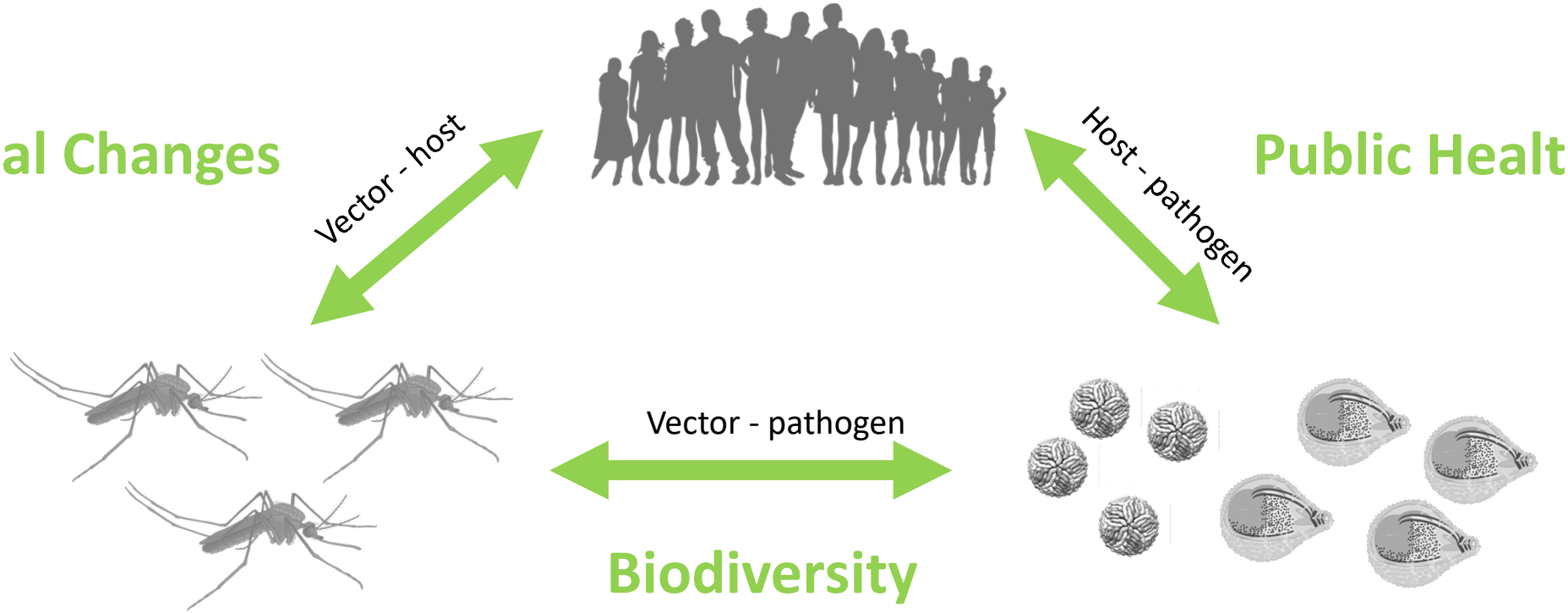
Medical relevance of mosquito-borne diseases



Complex interplay of mosquito borne diseases, biodiversity and global changes



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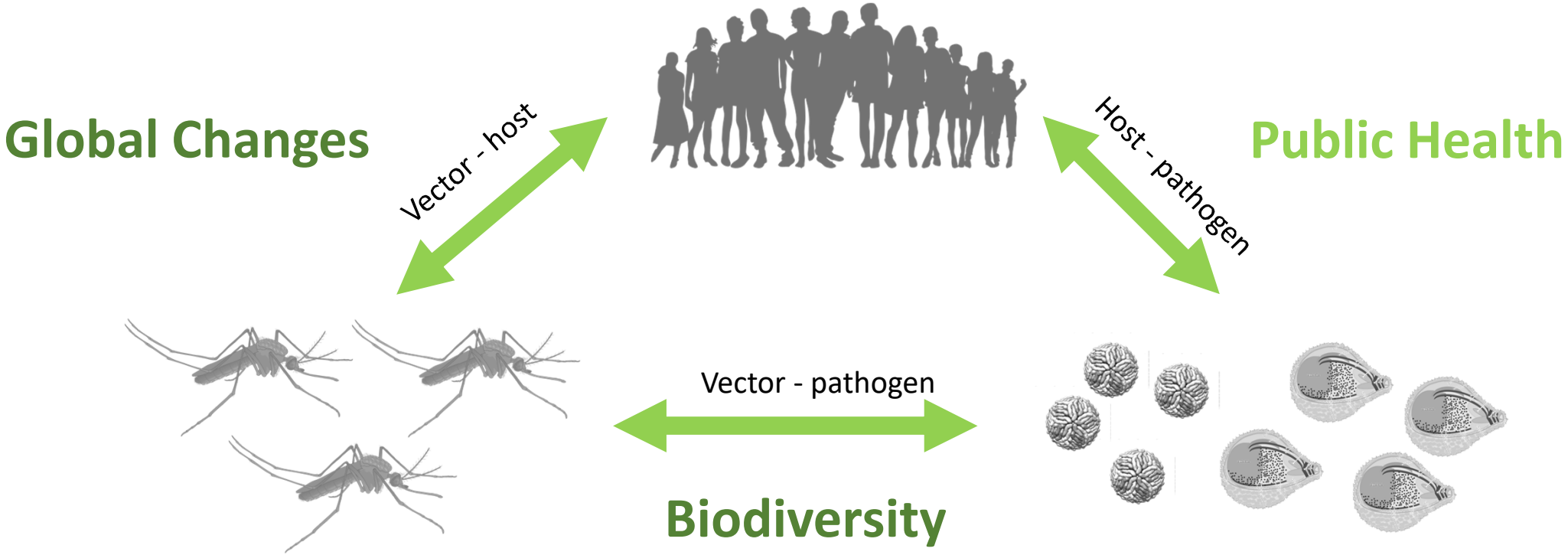
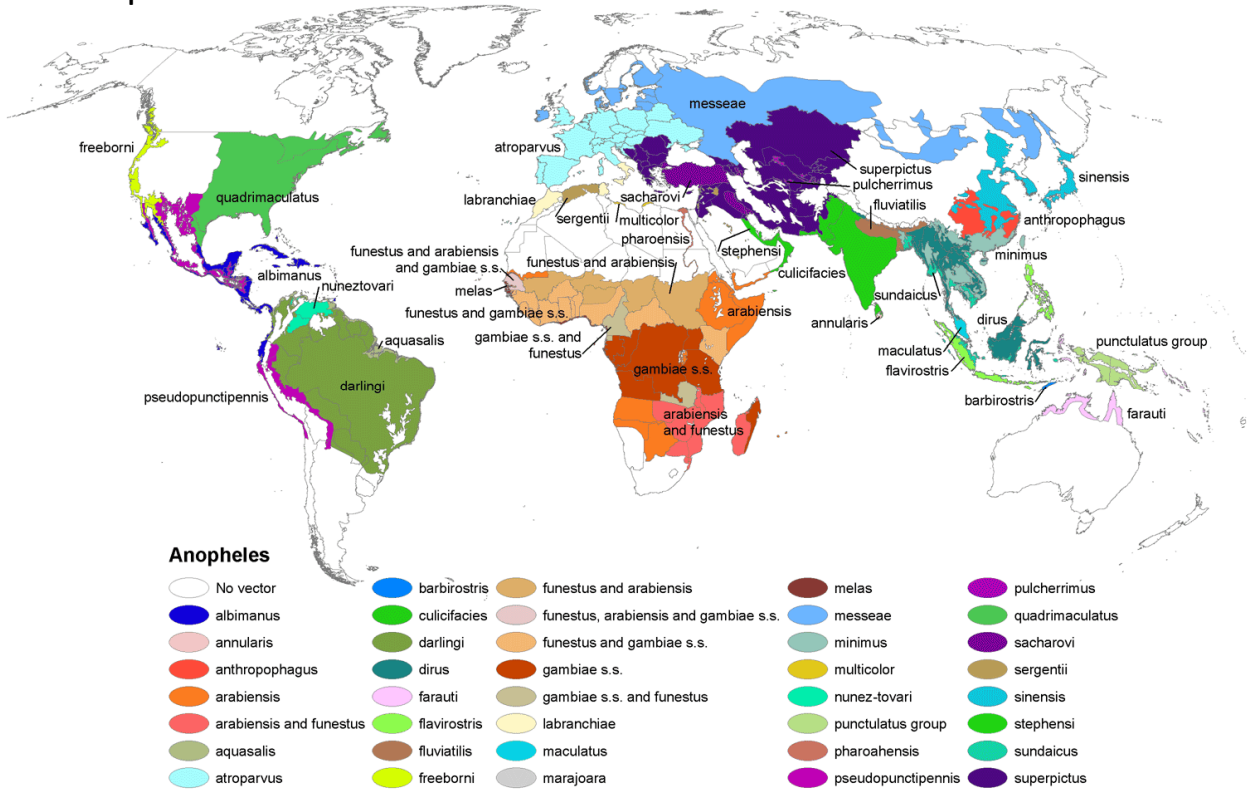


Disease vectors – high species diversity

Anopheles species



U.S. CDC - U.S.CDC, Public Domain
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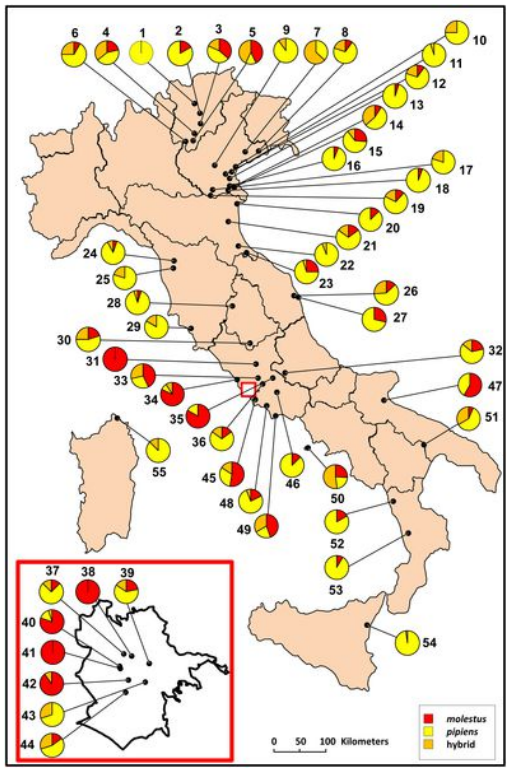
Culex pipiens & Culex molestus



Di Luca et al. *PLOS ONE* 2016

Life-table data & modeling: *Aedes japonicus*

Reuss et al. (in prep)

Experimental life-table data feed models for calculating population dynamics & climatic suitability indices

Cumulative female survival

Estimation of the number of potential generations per year with a low greenhouse gas emission model

(A) at present **(B) in the future 2041 to 2060**

Mosquito borne diseases & climate change?

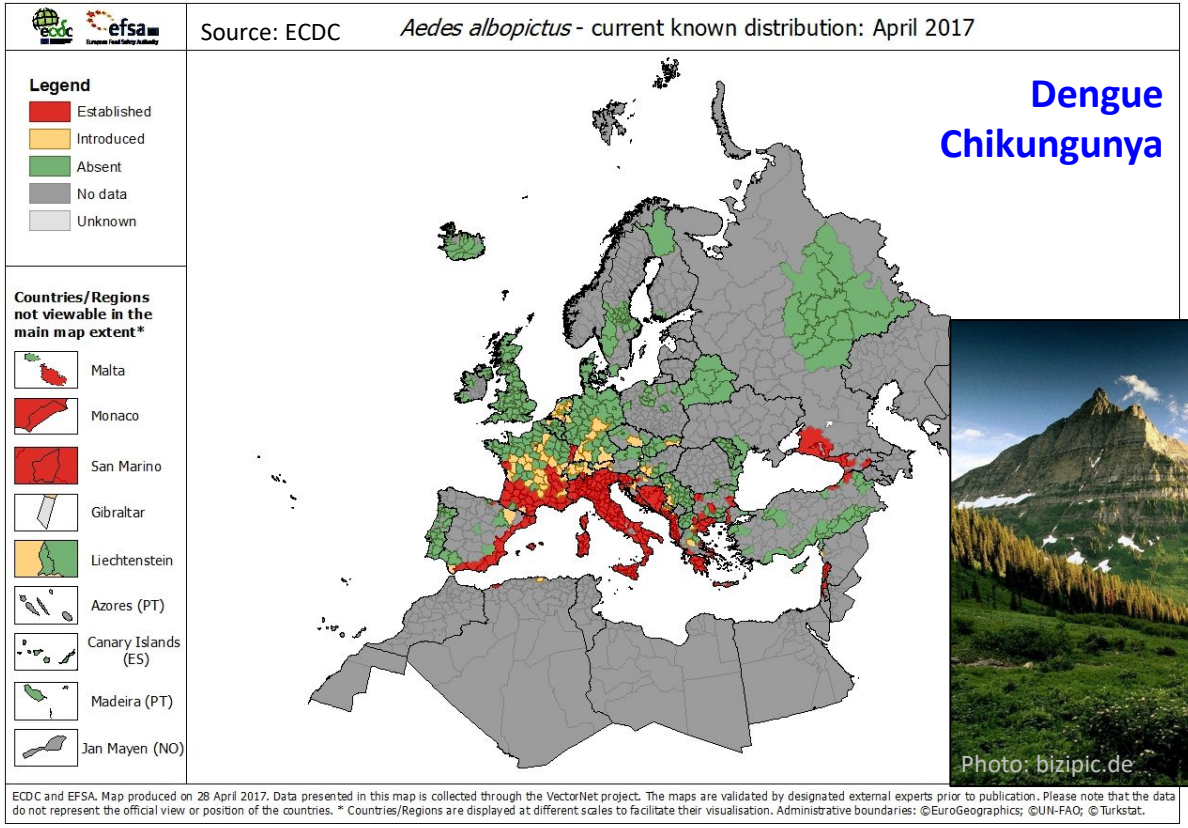



Photo: Mike Merchant

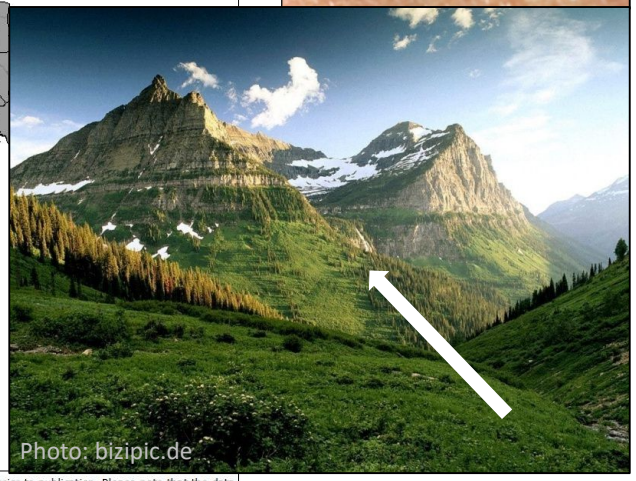
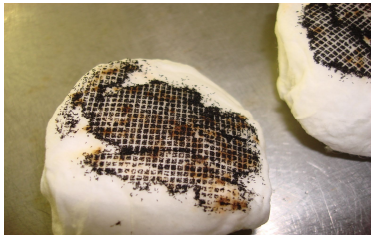
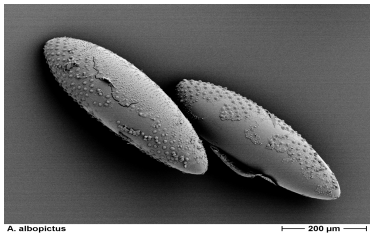


Photo: bizipic.de

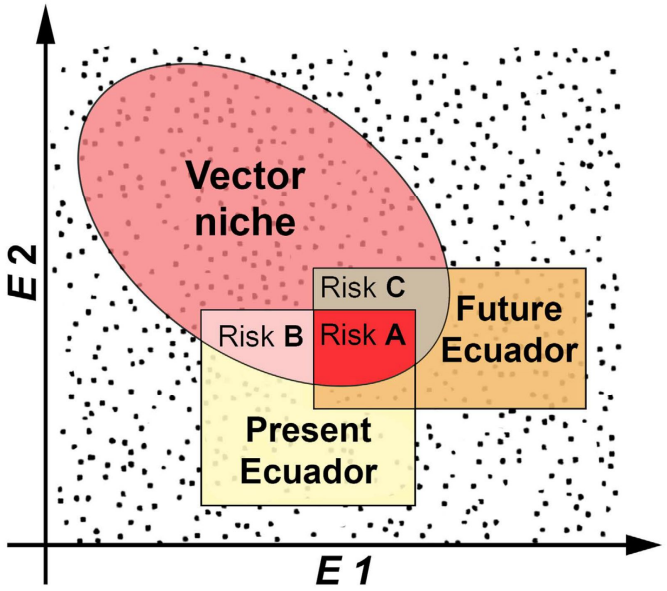
- Climate
- Travel
- Trade
- Adaptation

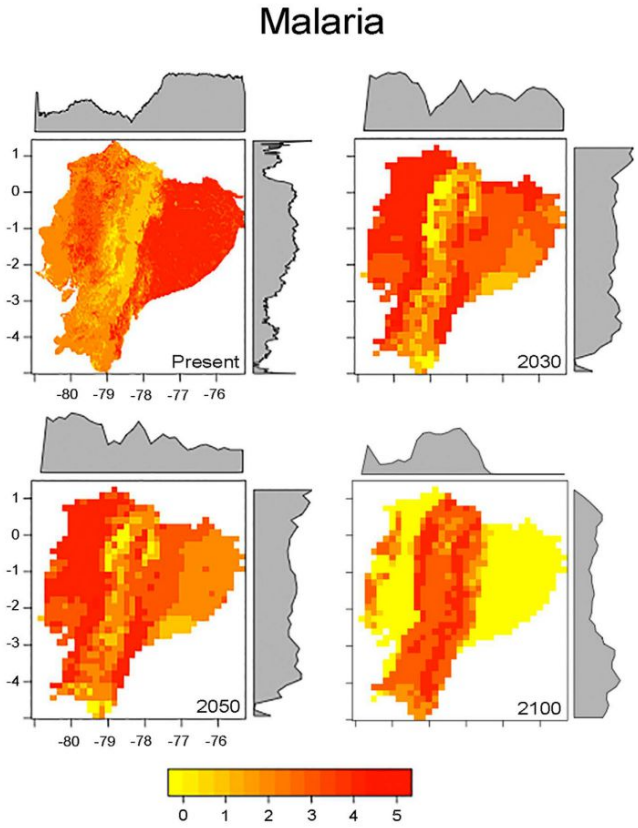




Life-table data & modeling: climatic suitability

Ecological modeling approach used to assess disease vector species' potential distributions and evaluate malaria transmission risk





https://www.veolia.com

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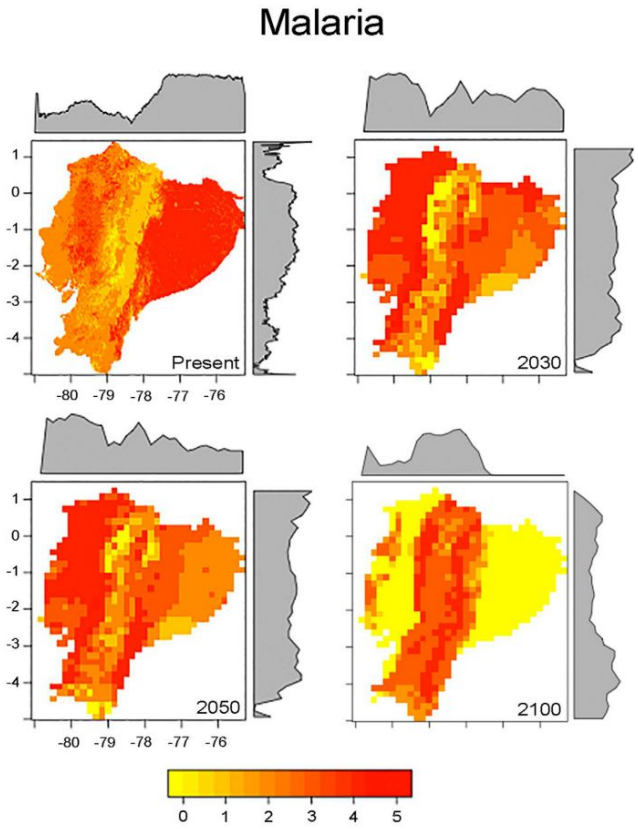
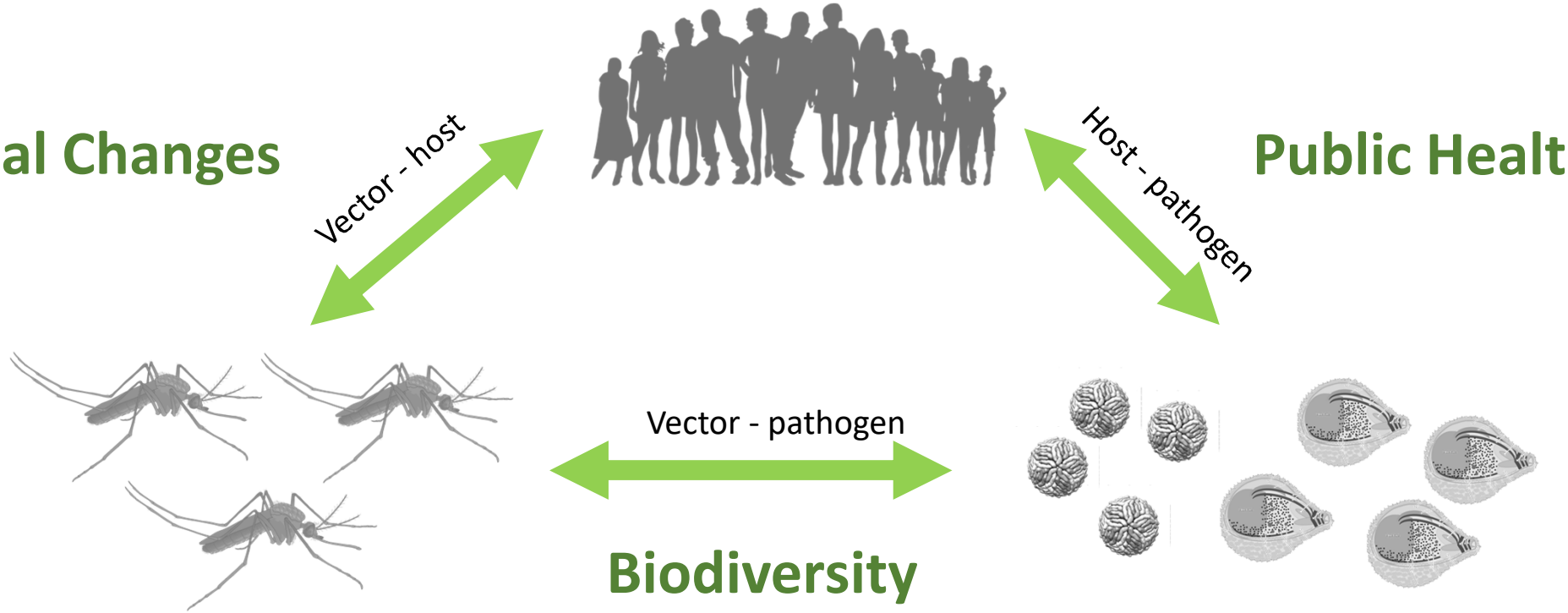
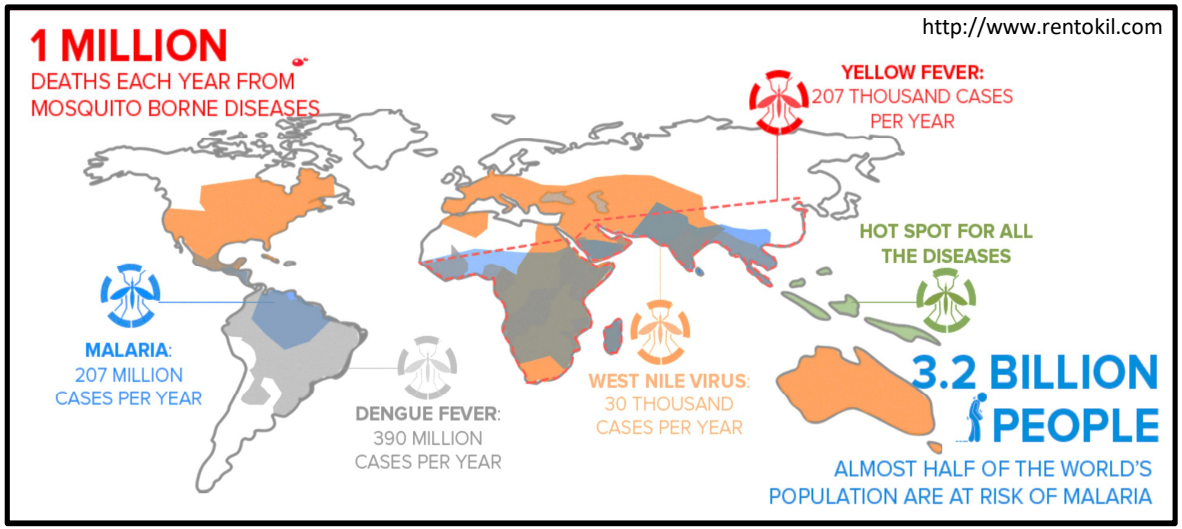


Complex interplay of mosquito borne diseases, biodiversity and global changes



Mosquito borne diseases & climate change?



Interplay of climate, mosquito biology with social & political factors

"Insect-borne diseases are not diseases of climate but of poverty."

Paul Reiter

- Political stability
- Good water service
- Education programs
- Mosquito control measures
- Public prevention programs
- Public health programs
- Vaccine programs
- Research

Knowledge level for prevention and control

Knowledge level for prevention and control of vector-borne diseases is very low in Nepal

- 77% heard of dengue
- 12% good knowledge

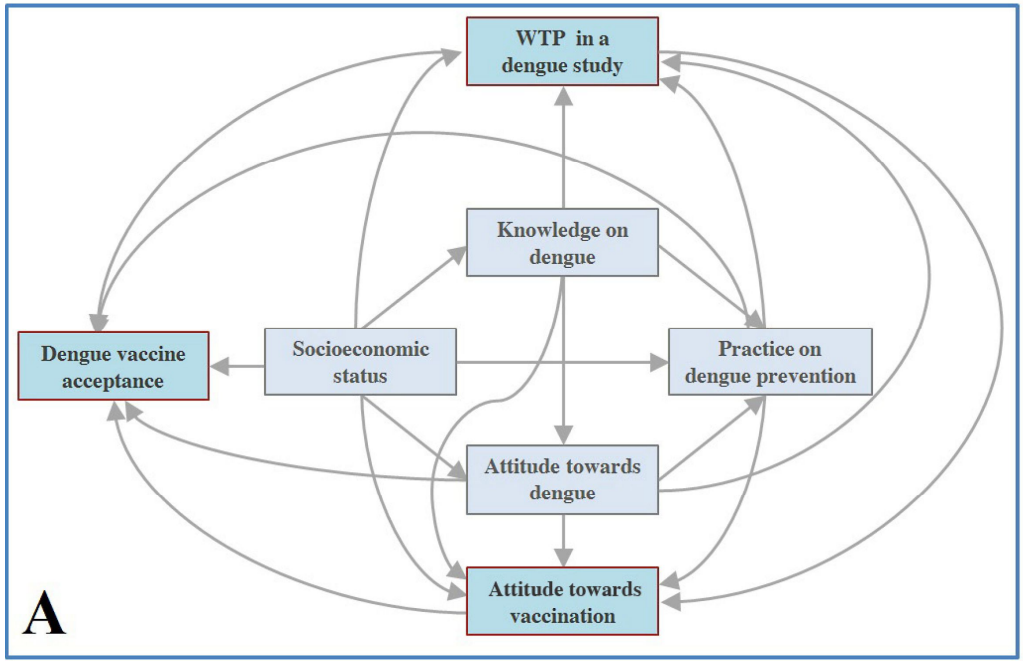
N=589

Lowland inhabitants 5 times more likely to possess good knowledge than highlanders

Dhimal et al *PLoS ONE* 2014

Dengue vaccine acceptance: Aceh, Indonesia

WTP - willigness to participate



- community-based, cross-sectional survey
- Several pre-tested questionnaires
- 709 participants

Harapan et al. *Southeast Asian J Trop Med Public Health* 2017

Dengue vaccine acceptance: Aceh, Indonesia

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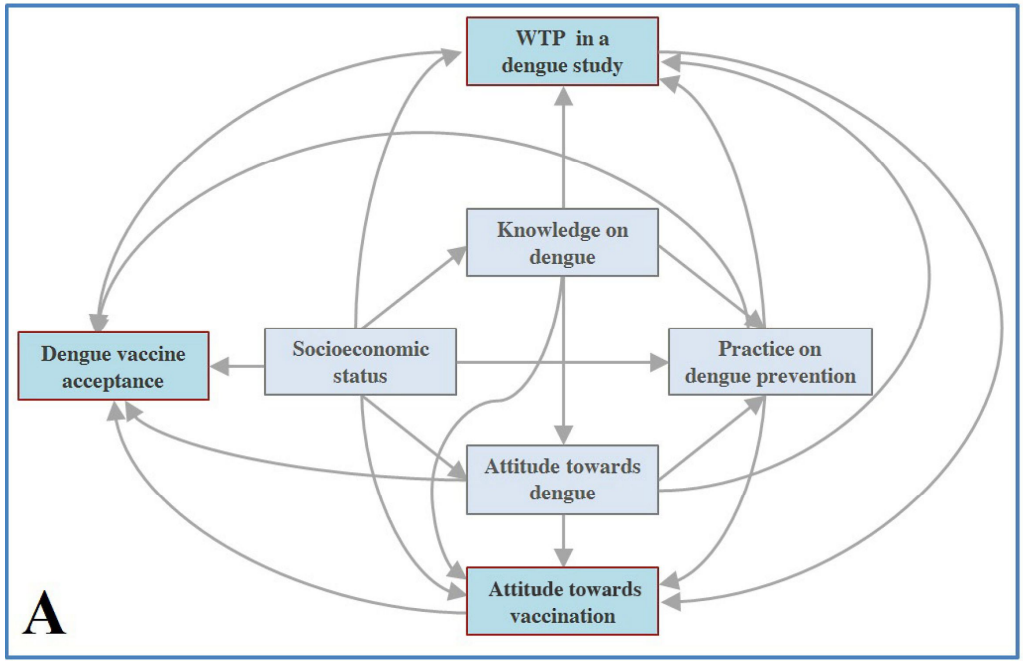

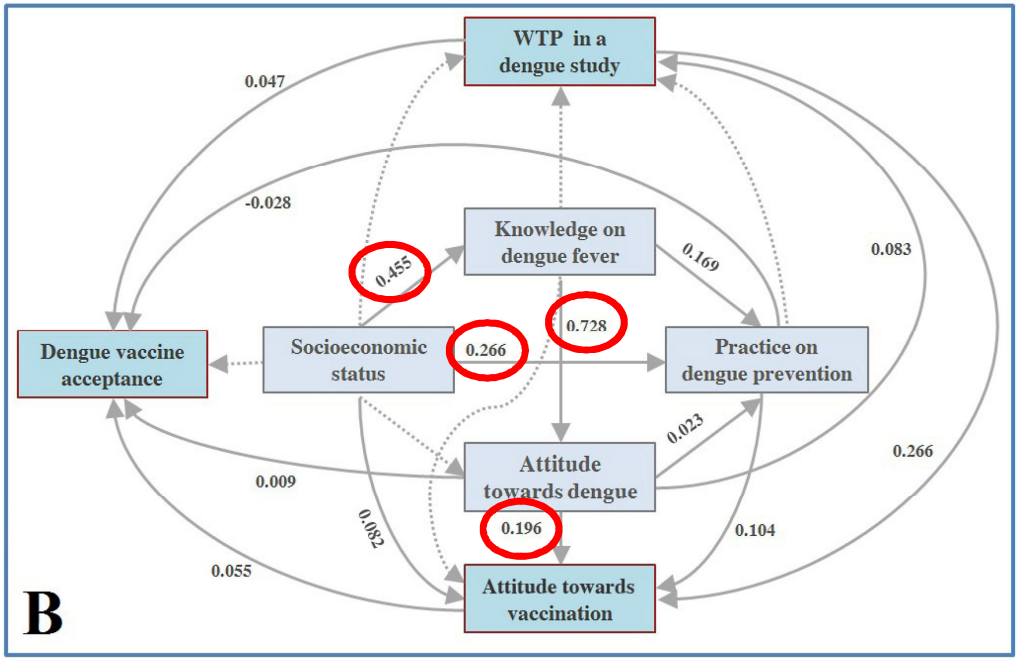

Harapan et al. *Southeast Asian J Trop Med Public Health* 2017

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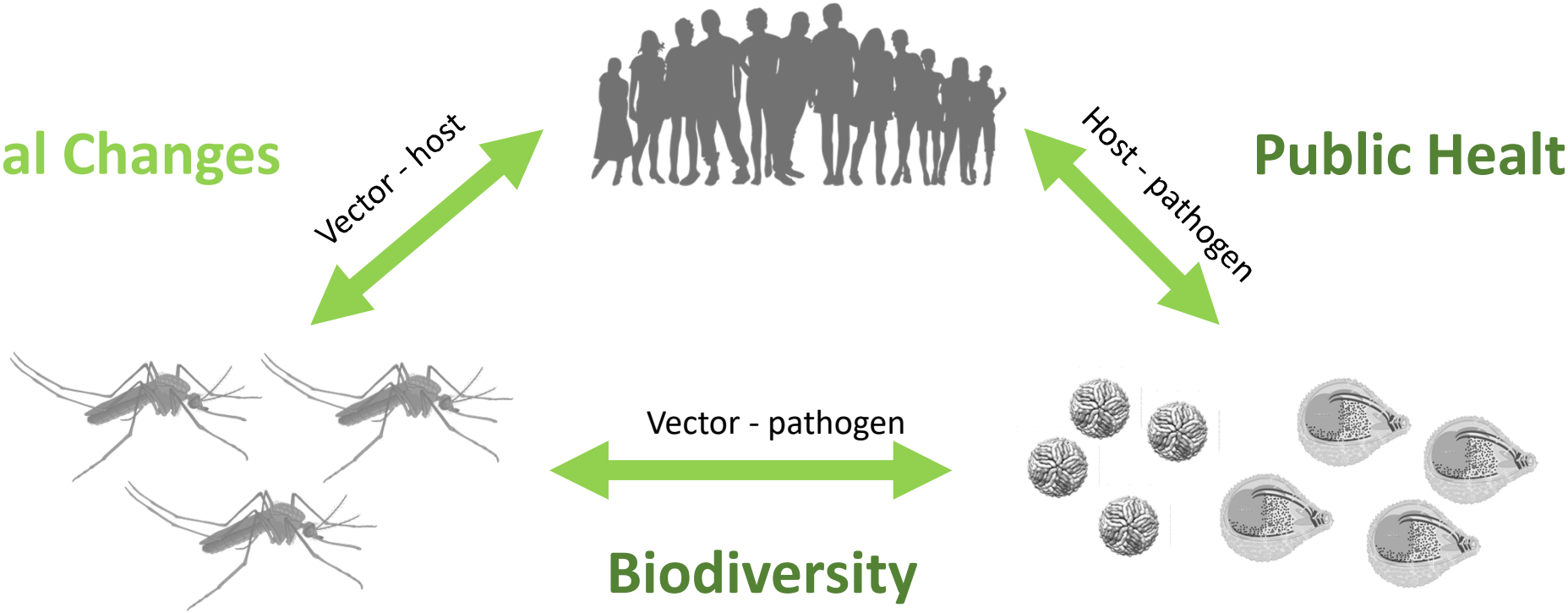

Vector control – insecticides

1st generation (large-scale use before 1950´s):

- Anorganics (sulfur, arsenic, mercury, lead, …)
- Petroleum
- Botanicals (pyrethrum, nicotine, …)

2nd generation (large-scale use since 1939):

- Organochlorides: **DDT**, aldrin, dieldrin, endrin
  → Stockholm convention effective since 2004

3rd generation – new synthetic insecticides:

- Organophosphates
- Carbamates
- Pyrethroids (used for bednet treatment)
- Neonicotinoids

4th generation:

- Bacteria, funghi → biodiversity as treasure → global change!
- New biotechnological approaches

environmental risks
resistance development

Vector control – biotechnological approaches

Sterility by Irradiation (SIT)

- Use **irradiation** to make the insects **sterile**
- Only affects the mosquitoes directly treated, it is **one generation only**, not passed on to offspring
- Requires huge infrastructure and **rearing capacity** – 5-10x local population

Sterility through genetic modification

- **Genetically modify** the target insect to make it **sterile**
- More precise and specific than irradiation, possibly with less impact on mating success
- **one generation only** – the modification is not passed on to offspring
- Currently used by **Oxitec** to control the population of dengue-carrying mosquitoes
- Requires huge infrastructure and **rearing capacity** – 5-10x local population

Gene drive-based modification

- **Genetically modify** the target insects to affect fertility or other traits – like the ability to carry a parasite
- It is meant to be self-sustaining: it is **passed on from generation to generation**, spreading through the target population
- **Best suited** to control diseases spread over large and remote areas, like malaria

Final conclusion

1. Complex interplay – mosquito borne diseases, biodiversity and global changes

2. Biodiversity – uncertainties in risk modeling of MBDs under climate change, unknowns about vector-pathogen interactions: species diversity, vector capacity, vector competence under different environmental conditions

3. Social & political factors – need on further understanding of eco-social factors, development of action plans in an One-Health context

4. Vector control – ongoing search for natural insecticides,
Engagement and openness are essential to build trust and to co-develop new biotechnologies with the countries that would potentially benefit from them

Thank you for your attention!

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http://www.lozan.de/biodiversitaet/biodiversitaet.html