

# ICMS–INI GCRF Seminar

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27 February– 2 March 2018

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Part I

**27 February 2018**

# Chapter 1

## Recap

Showed slides from EPSRC GCRF website.

- Address global challenges through disciplinary and interdisciplinary research
- strengthening capability for R&I within developing countries and the UK
- Agile response to emergencies and opportunities

Global Challenges = UN's Sustainable Development Goals.

Co-create research questions and outcomes. Test solutions to actual problems. Claims that interdisciplinarity is more common in UK than in many ODA countries.

- Research Excellence
- ODA compliant
- equitable partnership
- Impact: problem and solution focused. Speaker: Think Big!

What has worked and why? Case studies, mapping of existing work and partnerships. Existing models etc.

Speaker, happy to talk about case studies. What sort of community infrastructure might be needed. NB: some other disciplines well ahead of us.

### 1.1 Honora Smith (Southampton): OR Planning for ODA

Combinatorial optimisations (aimed at equity between people in same country). Simulation, Data mining.

Optimising the blood supply chain in Colombia.

**Q** Optimising ??

**A** ??

**Q** Interface with CS: data infrastructure in the country etc.

**A** Good point.

**floor** Look at the “data on the mobile” economy.

**floor** Vodaphone are tracking mobile phone location data in Ghana to track disease spreads.

**floor** Amazon drone development is in the UK, being trialled in Cambridge.

**floor** Drone delivery is an example of “Africa leapfrogging”, no old infrastructure to accommodate.

**floor** Peter Grindrod has a company using mobile data to reconstruct credit rating, being a difficult problem in ODA countries.

**floor** You said that people didn’t take up your advice: this is a typical problem.

**floor** Getting people with power to implement is important in Pathways to impact: my Hepatitis B project for example.

**floor** CASE students are a good model. But challenges with EU rules.

**floor** In Rwanda, we have MoUs with various policy-makers. This model improves likelihood of impact.

## 1.2 Goylette Chami

Speaker is pronounced “Juliette”. Computational and Big Data lead at Wellcome centre for Global Health (Cambridge). Main project in Mayuge District, Uganda. Mass drug administration<sup>1</sup> for neglected tropical diseases. Looking at water, sanitation and hygiene behaviours.

Look at percolation theory. Who should be targeted for cholera prevention if we can’t reach anyone. Who should be targeted to stop drug rumours.

**Conclusion 1** *A simple network-based algorithm outperforms the conventional “village leaders, schoolteachers and community health workers” approach.*

**Q** Definition of connection matters?

**A** Yes, “health advice” or “general friendship” are our general ones.

1. Select a household randomly

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<sup>1</sup>As opposed to diagnosis.

2. Ask whom they trust

3. ...

Similar approach to select lay health workers.

**Conclusion 2** *Tightly connected friendship networks are more effective.*

Also used unsupervised learning on symptoms to understand what diagnoses were being made.

Note there's a formal Cambridge–Africa programme: Cambridge and 30 African universities with hubs in Ghana and Uganda. Works exclusively with ECRs. African degrees but Cambridge training. Scientific questions originate from the African researchers, and we have a list of 200 potential mentors in Cambridge.

**Q** Does this lead to publications?

**A** Yes, very successful.

**floor** Does this form a clique.

**A** Also a PI from the host African institution. They collaborate via meetings at the hubs, and local networking events (funded by Cambridge). This also helps with the interdisciplinary problem mentioned above.

**floor** Rest of world.

**A** Oxford has a similar model in SE Asia. Vietnam and Bangkok.

**A** One problem is that African institutions have a publishing requirement for PhDs, which may lead to publication in predatory journals, simply because of speed.

### 1.3 Infectious disease modelling, surveillance and control

Example: human cases of H5N1. There is no recorded human–human transmission rate. Mortality rate high: 163/195 in Indonesia (highest!). So the question is how H5N1 transmits in the livestock population, then animal–human transmission. Map of SE Asia with ducks/sqkm plotted. Imperfect and aggregated data (Thailand at sub-district level). Need a model complicated enough to fit the biology and simple enough to fit the data. Looking at farm–farm transmission: depends on distant (what function?). Different ones for chicken and ducks. Needs farm sizes + rice paddies + duck density. But in fact duck density is the main driver.

What can we do in real time (rather than historically looking at whole outbreak). Uncertainty resolved only after several weeks of the outbreak.

**Q** What do you mean by “resolved”?

**Q** Similar question: what do you mean by stochastic system?

**A** Rate-based model. Question is whether you can get better informed priors from fitting previous outbreaks. These are essentially “training data”.

I have worked on foot-and-mouth, and there are very big models (being sold) with parameters chosen from specific countries. Very dubious.

High radius ring culling is robust (criterion being reduced number of infected flocks).

Pilot study funded by EPSRC under GCRF. This was canine rabies. Untreated human mortality 100%. Only 5% of infected dogs are reported. Work in Philippines. There is no obvious correlation in the data. Developed a mobile phone app to improve surveillance. Acronym BITERS (Bite Incidence Tool ...). Very weak connection between human and animal health there, which we’re trying to fix.

**Q** How do you know only 5%?

**A** Good question. A couple of detailed surveys have been done (in different countries). Maybe 5–15%.

## 1.4 Wirichada Pan: Infectious Disease Modeling

Leptospirosis (not very prevalent 5/100k, but had outbreaks, common ( $\times 10$  national average) in two very different regions: small sub-areas, one each in south and north-east) and rabies are the two major issues in Thailand.

Early diagnosis is different. Occurs in poor people Under-detection/reporting are prevalent. Lab tests not easy/fast. Detecting leptospiremia directly (PCR) is expensive. Data: clinical, rodent,(in villages and in fields separately, at least in NE Thailand), livestock/pets and environmental sampling (water and soil). Model needs animal/human contact data, collected via an app. Also look at water sources, and animal contact.

Looks at very changing population dynamics in SE Asia. This impacts distribution of diseases. Melioidosis is under-reported. Have a transmission model, where urbanisation is a key factor.

**Q** What is Melioidosis?

**A** A bacterium, can be inhaled, and 50% mortality.

## 1.5 Discussion

- UK GDPR and privacy will have knock-on via Commonwealth informal take up.



- Issues around mobile data collection: privacy, but also battery drain.
- “Zimbabwe runs on mobile money: there is no cash”.
- European biotechnology Institute (EBI) working on big data, both supervised and not. Claim (first speaker) that we need explicable personalised medicine more in ODA because of weaker health systems, misdiagnosis and resistance. Note Lassa fever outbreak in Nigeria.

## 1.6 Combination

### 1.6.1 Health

- Health care insurance (China)
  - Data collection/anonymisation
  - Forecasting
  - Aging population (Southampton)
- Mobile
  - Finance
  - Health monitoring
- Resource allocation (EWGLA, VEROLOG EU projects)
- Emergency preparedness — algorithms for outbreaks etc.

### 1.6.2 Others

- “Platforms are really useful”, bringing people together as teams. Lots of good little bits.
- Stakeholders are useful (know their agenda): note agriculture agencies already in Africa, in particular.
- Universities do great things for own research students — what about the overseas ones?

**Part II**

**28 February 2018**

## Chapter 2

# Morning session

### 2.1 Alf Onhuus

Mathematician in Bogota, specialising in Model Theory.

**Columbia** 40M people; 10M in Bogota

**Status** Just signed a peace treaty with guerrillas, but very polarised

**Ecosystems** Areas where guerrillas were active are undeveloped

**Water** páramo (mist captured by plants)

**Colciencias** (is their research council) budget 100Meuro; more than half in PhD training overseas.

Colciencias is in charge of identifying and classifying researchers in Columbia: junior, associate and senior (6K/2K/1K).

Classified by publications: 10 articles in 10 years for senior. Only 10 mathematicians. Quality of publications is measured by impact factors. 4 years ago they switched to quartiles (within subjects). Good growth curve of Scopus articles.

ICM 2018 will have its first Colombian invited lecturer.

Low science budget, fear of cronyism. Hence no peer review, and no culture of it.

Top researchers: 3 physicists (all CERN), 3 MDs and a chemist. Next iteration had two chemists (since the sector is physical sciences). 76 scientists with the most influential career doesn't have any mathematicians. Hence a vicious cycle. These people have no interest in normalising the publication data.

This is not a phenomenon unique to Colombia. Spain requires 5 articles in six years.

The IMU recommendation was "don't use metrics". That's fine for UK/Germany etc., but the lack of distinction doesn't help. "Metric Tide" puts Norway/Spain in the same category, but these are really pretty different.

**Q** Peer review is felt to be internal: should we have an international peer review process?

**A** Good point. We have applied maths as well, but it's not visible.

## 2.2 Isabel Moyo/Zimbabwe

National University of Science in Zimbabwe (“the other one”). 15 universities: 8 state, 6 private plus “open”. Research Council in Zimbabwe: offers no funding, but runs influential conferences. Agriculture is the main area at these.

Wants to use extreme value theory for climate modelling.

One opportunity is solar energy: big project, but very slow. But is very grid-oriented. But I am not connected to grid at home: use direct solar.

Also Matabeleland Zambezi water project — industries and livelihoods. Dam to collect water and power. Project also stalled. No mathematicians involved.

### 2.2.1 Challenges

#### **Funding!!**

**Isolation** Zimbabweans abroad don't come back and connect.

#### **Expertise**

**Interest** Curriculum is very theoretical. Problem-solving is very late, typically final year university.

**Infrastructure** Software is hard to get.

**Q** We have a project on demographics of faculty. Also capacity in statistics and data science.

**A** It's largely youthful.

**Q** EuMetSat has estimates of solar energy data, and there's a major maths problem of interpretation. A little work in Kenya has shown it's very valuable.

**floor**

## Chapter 3

# Post-coffee

### 3.1 Neave O’Clery: How mathematics can play a larger role in Development

A Skype lecture. I studied in Dublin, and Mathematical Modeling MSc at Oxford. Then PhD at Imperial (very conventional). Started a “policy publications” group, which grew. Then Center for International Development at Harvard, which is the biggest data source. Now at Oxford with Grindrod.

#### 3.1.1 GCRF: Economic Development via Knowledge accumulation

First cross-council GCRF. Involves governments of Colombia, Mexico, Ireland, World Bank etc. Also Peking University, Cape Town University and others. At Oxford, Maths, Medicine, Geography and Anthropology.

Claims divisive school education — “you’re good at maths” / “you’re good at English” causes problems. Part of the US doesn’t take the Development Goals seriously. Claims that you need to engage with their theories: six books, e.g. Jane Jacobs: the Death and Life of Great American Cities. Also a book called “Evicted”.

“It’s important not to neglect causality”, .e.g impact of telecoms on development and well-being. What’s the causality: do telecoms breed higher incomes or vice versa? Economics etc. don’t take association studies seriously without proper causality. Policy makers are used to seeing regression tables. Mathematicians complain that policy makers don’t take models seriously, but this is failure to speak the right language.

There are major questions mathematics can address.

**Q-AM** How does the team work.

**A** PIs have just has a first grant meeting. Lots of bilateral working. In practice Oxford is just one partner.

## 3.2 Kgomotso Susuan Morupisi (Bath/Botswana)

Research student with Chris Budd. 2/3 desert: most people (2.2M in all) live near Zimbabwe and SA borders. Agriculture/Cattle is the main business. 7 universities, only two with Mathematics: University of Botswana, and new Botswana International University of Science and Technology (2005). All teaching in English (official language). There is essentially zero funding. No mathematicians in the Technology hub (only source of funding).

Sparse and late rainfall is a major problem, affecting food production. HIV/Aids is also a major problem. Children born with HIV are now causing new infections. Foot and Mouth disease is also a challenge: beef is our main export. Cordoning hasn't really worked. We have good roads by ODA standards, but a lot of traffic accidents.

Mathematics teaching is very abstract (as in Zimbabwe above), which means that collaborations are rare. Agriculture has a lot of data. Capacity building is a real problem.

**Q** PhD topic.

**A** Climate models, especially how it affects Botswana agriculture.

**Q** Is there a Botswana math soc.?

**A** No, but SAMSA, which runs up to Kenya.

**Q** Botswana is a hidden jewel.

**A** 24 statisticians, 17 with PhDs, and possibly best in Africa.

**Q** There's a group in Cape Town doing climate projection.

**A** Need to get in touch with them

**Q** Inter-country links?

**A** We're trying to collaborate with Stellenbosch.

**Q** Why reluctance to collaborate?

**A** I don't understand — even intra-university is difficult. There is a bimodal demographics which doesn't help.

# Chapter 4

## Afternoon sessions

### 4.1 Sourav Mondal: Unifying disciplines toward solving a global challenge

#### 4.1.1 India

>  $10^9$  people so everything is large. Notes IITs, Indian Institute of Science Education and Research (8 of, 2002–2016 foundation). CSIR labs.

**Environment** Air pollution **water pollution**. Arsenic is a major problem. WHO limit is  $10\mu\text{g}/\text{l}$ . IIT has developed a soil-based filter which can be safely disposed of, producing water at  $0.3\text{UDS}/\text{m}^3$ . Can reduce arsenic from 250 to  $< 10$ .

**Maths?** Need to study the exhaustion limit, lifetime. Have an equation, depends on  $\gamma$ . 5 years for household and 8 for community. Also can reverse engineer and see what we need to produce a 10-year filter. Note that laboratory experiments are infeasible. GCRF funded and won various awards.

**After GCRF?** From the UK side can look at Newton fund. RS international collaboration. RCUK (DST-UKRI).

**India** DST, also EU–New–INDIGO and the new VAJRA scheme.

**Manufacturing&Materials** Aim at low-energy production.

**healthcare** Indigenous production in an effort to competitively priced.

**Q** Perfect case study.

**A** This is submitted to a Water Research Journal

**Q** There are also business/humanities centres.

**A** Yes, but my perception is that these are more teaching institutes.

## 4.2 Sukumar: ZED-I

Reference to Star Wars. This is Newton funding, though it could have been GCRF. £1.2M UK side, and similar effort from India. Started Nov 2017 (or Jan 2018 in India).

Decouple building energy use from economic growth using a new science of zero peak energy building design for warm climates.

People/Network/Climate. India has 6 of the 7 climate conditions common across the developing world, hence we have translation possibilities. Big cities mean no supply hours in April 2016 were 10–17 (Bengaluru). A lot driven by cooling energy demand. People with money buy generators, but the poor are disproportionately hit. problems of excess mortality. Claims that this is not a supply problem, but at least equally a demand problem, which we should address.

Note that minimising peak might mean raising mean.

**Q** Where's REF/Impact.

**A** Different views in India/UK.

**Q** Looked very modern: what about Indian context, traditional materials/knowledge etc.

**A** There's a real problem with the international style of urban development, but also aspirational issues in the Indian culture. There was a fantastic piece of work in Egypt 30 years ago, but the new one is hopeless by comparison, but everyone would prefer to live there for aspirational reasons.

## 4.3 DS Arya

IIT Roorkee is in the last city before the Himalayas, 180 km North of Delhi. Started with a 500km canal, built under British rule (Royal Artillery), started 25 November 1847. 5000 students, 18 Departments. Many international students, great alumni network. Not Botswana, and Zimbabwe only on short courses.

Climate change is a major area, especially effect on groundwater. Also a large project in Groundwater Arsenic.

In general, issues in connecting open data sources to other sources. Now getting data on a systematic basis. UHI [Urban Heat Island] produces 2–4C currently, probably more with climate changes. This affects rainfall patterns (shifting from one side of city to another). Hence water modelling is a major project, integrated model rather than discrete models of rivers. There's a purely command line program available, but it's inflexible w.r.t. data sets and changing land cover issues.

Also work in dam rehabilitation (world bank funded) to allow for climate change.



List of mathematical issues, GCM/RCM data, bias correction against open data sources, Uncertainty analysis (range of scenarios). This leads to stochastic hydrology.

Looking for partners in collaborative research, capacity building with short-term competency building programmes, regular faculty (short by 100), visiting faculty etc.

SN ZED-I had its genesis in the 1-week capacity-building visit.

**Q** What data.

**A** We are using GCM data dynamically downscaled to match our current point data. We can handle 25km resolution data, as it matches our experimental data.

**Q** But there's also issues of temporal resolution. What hydrological input goes into the GCM?

**A** Working IITM's GCM are saying that their model (?and the Met Office: JHD didn't follow).

## 4.4 Patrick Dunn: Africa

Warwick the OR in chemicals. I believe that maths is an amazing liberator from poverty. Then founded Warwick in Africa in 2006: training teachers etc. Affected 500K Africans. Get 30-40% improvement in results at £10/learner/month. Big gender issues — “girls told they're no good”. Example of 31 teachers on payroll, but only 10 real ones.

ESSA is a go-to knowledge hub about education in sub-Saharan Africa. Heard a plan to build 500 new universities in Africa, but no ideas about faculty. Hence we concentrate on joined-up plans. Educational statisticians can learn a lot from health statisticians, and could do more work on ghost teachers.

We have all the educational research done *in* Africa. Gaps etc. flagged. Went to UN World Data Forum. “There are not enough, and the wrong sort, of statisticians”. Need communicable infographics rather than tables.

Note that the foundation tend to fund scholarships, but these are not being directed strategically.

**Q** You come from a different world.

**A** Yes, but we should communicate more. You should talk to alumni more. Example: why could we collect Ebola data but not attendance data at rural schools? Tanzania is recruiting teachers like mad, but typically in humanities.

**Also** In SA, for example, the pass mark in Matriculation Maths is 30%, and schools boast 90+% pass rates, but that's only of those who are submitted!

## 4.5 JHD

## 4.6 Summary

**Q** What contacts do you have?

**JHD** Mentioned Lisema. Also ZED-I.

**NM** ZED-I.

**SN** Also Bangalore. The field work has built links with other IITs in particular. Mexico.

**Onshuus** JHD, also Manchester, Oxford.

**DS Arya** A project with Sheffield, over storm water in Indian cities. Would really like big data (i.e. really large data sets) expertise. I'm interested in the connections with Botswana and Zimbabwe — the latter might be able to get a three-month visit to India. Related question is a look for BRIC contacts in the area of disaster management. Also contacts

**David Mond/Warwick** Contacts in Brazil, especially USP Sao Carlos, but they have research students who have moved all over the State. José Seade at UNAM (ex-Oxford) has a PhD in Singularity Theory, but he's Director there, so has responsibility. I also teach the interdisciplinary course in Climate Change at Warwick.

**Sourav Mondal** Apart from my project, also guy in Tanzania, and an Institute Director in Cameroon.

**Apala** IIT Delhi, IIT Mumbai (co-supervised), visiting professor in Bangalore. Connections in Chile, and in UNAM (Mexico).

**Case Study** Really liked the Arsenic work. ZED-I could be one, but isn't ready yet. There's been some work (David Stern<sup>1</sup>) on corruption in Africa.

**Infrastructure** Quite well described in the presentations. India has substantial investment in research. SN noted that DST had just announced 12 more UK-India

**Challenges** A lot about India.

**What would you like** Funding! Also help with wider dissemination. SN: there are data challenges with respect to data collection for, for example, Climate Change/emission goals. AO would like work on assessment on science. Apala asked how this might be achieved.

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<sup>1</sup><http://kenya.africanmathsinitiative.net/?entry=entry110722-162643>.

**Part III**

**1 March 2018**

# Chapter 5

## Introduction

GCRF = UK research contribution to UN Sustainable Development Goals. £1.5G over 2016–2021. UK Research Councils and Academies are delivery partners. We are here because EPSRC recognises that Mathematics is under-represented. Noted that collaboration within the UK, and even within the same UK institution, isn't trivial. Apparently at Kent, OR is the school of social sciences.

- Identify specific challenges
- opportunities for quantitative methodologies to tackle there and make them tractable
- identify ways forward (and case studies).

### 5.0.1 Mike Ideas

Networking grants; Demonstration Projects; Postdoctoral Fellowships. See also Neave's talk: vision+postdocs. A common theme is that "people don't understand what maths can do": hence a lot of public engagement. Note the success of Maths+Industry (ESGI etc.) built up over decades. What might Maths+Development look like. Note that the RCs won't support studentships outside CDTs, hence do we want to set one up?

**Beth** Note the success of ICTP in Trieste in incorporating developing countries as a model. Also what

**Abrahams** ICMS/INI are modeled in part on ICTP, but have not really copied across that aspect.

**JHD** CDT call expires in two weeks, so we won't make that. All we can do is lobby EPSRC/?? to include in the next call.

**Beth** All good, but why can't we have a scheme for adding ODA studentships into already funded projects.

**Warwick** CDT good idea, but also MSc programmes should be considered, as they are faster and easier.

**ICMS** ERCIM is gathering next month.

## Chapter 6

# ODA Representative talks

### 6.1 Fred Tangang, Malaysia

Addressing Information Gaps and data Needs for Adapting to Climate Change Impacts in the SE Asia Region through the SE Asia Regional Climate Downscaling (SEACLID) project. Images of Bangkok flood 2011. Cost 45G USD in damage, Also super-typhoon Haiyan caused over 1000 deaths, etc,

The region is very dependent on the mega-deltas for rice-growing areas. But ICPC data has many “insufficient data” over SE Asia. GCRM works at 300km resolution — insufficient. CORDEX is a forum for discussing and coordinating regional efforts. Currently working on 25km resolution. UKMO contributed one run. Five active countries (Lao, Cambodia don't really have capability currently). Want to get to the point where we can do our own model runs. Consecutive Dry Days (CDDs) are projected to increase under even moderate climate change scenarios. Paris aims for under 2C rise, but this looks unrealistic.

Workshops in various countries. ICTP has contributed \$10K to fund young researchers. There's a research centre in Thailand now (speaker a visiting professor there)

**??** We have a proposal in on the Mathematics of Flooding, but need contacts in ODA countries: can you help us. Also a project on agriculture in brackish water, e.g. samphire. DS Arya recommended his Hydrology Institute.

**A** Various comments. Emphasised size of data challenges, e.g. 180TB.

**Reading** We have collaborations with Iranian counterparts. Have a proposal for S Asia. We want to take river basins as the units.

**Beth** We need to talk about computing — all this involves significant computing.

## 6.2 Brazil Centre for Disaster Reduction: CEMADAN

LBL Santos (Director of Maths branch of centre). We have observation in Brazil and neighbouring countries. Hydrology does respect frontiers. <http://ieeexplore.ieee.org/document/7999247> described what happened when one state was cut off for 60 days.

### 6.2.1 Colleague

Landslide prediction and mitigation depends both on rain forecasts and the current state of the geological layers humidity. Sensors are very expensive, so we are starting a project to develop cheaper ( $\times 5$ ) sensors. Following modelling (commercial package) we see that human settlement (layer disturbance) is a major factor in landslide sensibility. So the first metre is not natural soil, but anthropogenic.

Case study of major oil refinery in Brazil, in a mountainous region. Also nuclear power plants.

Drought research group, focusing on Brazil's NE (major drought-affected region).

**Q** Really good case studies!

**Q** You are on short time-scales than the previous talk. Is there any scope for looking at longer time-scales.

**A** Good point.

## 6.3 Pheakdei Mauk (Phnom Penh): Mathematics/Government Policy

So far Cambodia has mostly interacted with the French (where I did my PhD) and first time in UK. We now have a 2015–25 Industrial Development Policy. Involves reducing price of electricity and improving coverage, Transport master plan. Labour market and skill development. Transforming Sihanoukville Province into a Special Economic Zone.

Many dams on the Mekong River in other countries, which has effects on Cambodia.

6 PhD in Mathematics Departments. A 4-year Bachelor programme aimed at teachers at my university (only one). Weekend Masters programme initiated by CIMPA (France), but ended in 2015.

But PhDs who come back to Cambodian universities are drowned in teaching. No research funding. International cooperation is very low, and lack of a research culture in Cambodia as a whole.

**Q** Would it be beneficial if your students could come to UK CDTs and go back to Cambodia to become the trainers.

**A** Possibly 5/year, at least to begin with.

**Q** Co-operation with neighbouring countries?

**A** Some. CIMPA funded scholarships for short studies in Vietnam.

**floor**

## 6.4 “call me Tu” (Lao)

From the Faculty of Environmental Sciences in National University of Lao. 6.8M people, 70% in agriculture. Electricity has been a major push (more than 100 dams), and now mining (mostly run by Chinese).

Flood is a major problem, both lowland flooding (half of the country) and flash floods in mountainous areas. But also Drought: predicted 30% drop in agricultural production. Need a crop-switching model.

UXO [Unexploded Ordnance] is a major problem, affecting half the country. This problem will be with us for 150+ years even with foreign aid (Obama promise etc).

There is a Mekong River Commission, but it's pretty toothless, partly as a result of poor quality of the models currently.

GCRF could help with modelling (a set of standardised models to predict and tackle disasters), also studentships for Masters and PhD students. But many students are afraid of mathematics. Most Lao students how speak English. They are often sent to Thailand, Vietnam or China.

**Q** Where do you need the mathematics?

**A** The economics models are not very well connected to the real world (laugh from audience).

**Q** You are almost calling for an expert system. But there's also the need for computation, as we heard before.

## 6.5 Afternoon session (General)

Where does maths make a difference? Smith Institute had a bunch of case studies.

?+**Ulster** Aftershock prediction: deployed in the field with an app carried by earthquake rescue workers.

?+ Vulnerability index for flooding. Bangladesh

?+**India** Clusters of malaria identification via geolocation.



?+**Tristan da Cunha** Probabilistic evaluation of risk for evacuation.

?+**NERC PURE<sup>1</sup> scheme** Vulnerability index for flooding: Nepal,

?+ A nutrition study, with no mathematician to do the analysis.

## 6.6 Mathematical Sciences in Development

Robert had an SDG-driven list. Also a list of cross-cutting themes, notably improved data collection via mobile 'phones.

**Food**

**Health**

**Water**

**Energy**

**Economics and Finance**

## 6.7 Resumé

AIMS was a good example, showing how one can do high-level training that made a lasting effect. Could one imagine creating a Center for Development Mathematics.

It was noticed that South America does relatively well for MSc and even PhD training. but very little at the postdoc level. Noted that H2020 does well in this way for Europe.

### 6.7.1 Annunziata ??

- Data acquisition and retrieval
  - Data access
  - Data quality
  - Data availability
  - Data analysis and assimilation (added from a remote participant)
  - data management
  - Data type (disaster, infrastructure, demographics, social media)
  - Correlation algorithms
  - Identification of hottest parts
  - scaling issues (upscaling/downscaling)
  - Climatology is more than rainfall.

- Challenges
  - Forecasting/Prediction
  - Policy Making.
- Opportunities: decision making
  - Disaster Management Cycle
    - \* Mitigation
    - \* Preparedness
    - \* Response
    - \* Recovery
  - scenario-based modelling
  - Dynamic Optimisation

**floor** We have a centre for under-utilised plants, based in Malaysia. Note that there are lots of these, so one can't afford to investigate every one experimentally, hence importance of modelling.

**Director** New grant will have "strategic workshops" for rapid response.

**floor** You should contact the Mekong River Commission

**Q** But who there is mathematically sympathetic?

**Part IV**

**2 March**

# Chapter 7

## Summaries

### 7.1 Day 2

Looked at disease modelling, including water-borne, animal-borne etc. Also a look at insurance models. New areas in medicine will create new areas in Maths.

**Q** What are the relationships between Mathematics and OR. Is there scope for more mathematics.

**A** Yes, the OR people are always open to new ideas.

**Q**–**Roger** Climate is an important factor. See Columbia’s Institute for Climate in Health, especially Madeleine Thompson (ex-Liverpool School of Tropical Medicine)

**A** Helpful.

**Q** There may well be new areas of theory to apply to new problems.

**A** True

### 7.2 Day 3

JHD summarised.

### 7.3 Day 4

**Flooding**

**Extreme weather/climate**

**Landscape prediction**

**Multiscale data** and new forms of data, notably mobile 'phone data which may be the primary source, rather than formal government data. There is also a need for cheaper data samplers, and better use of satellite data.

**Computation** Possibly shared computational power, but also better algorithms to reduce need for HPC.

**Decision making and policy** Strategic, tactical and operational.

### 7.3.1 Resources/Initiatives

**AIMS**

**MUII** Cambridge/Uganda+ epidemiology study.

**CliMathNet** <http://www.climatenet.org> running since 2013 to increase dialogue.

**LWEC** Living with Environmental Change — EPSRC.

### 7.3.2 Issues

**Mathematics of Flooding** PDE and numerical modelling. Also control theory.

**Landslide** uncertainty analysis.

“**Soft OR**” skills , such as system dynamics and problem

Note that disasters imply both uncertainty and dynamic matters.

### 7.3.3 What do we want?

- Training: an ODA CDT, or rather adding ODA students to existing (new round) CDTs.
- Institute for Development Mathematics (possibly distributed centres).
- A multi-disciplinary Decision Support System, including climatology, meteorology, hydrology, seismology etc.

## 7.4 Summaries etc.

Noted that we haven't really had a classical statistician here this week: need to incorporate such views retrospectively. Note that the GCRF area is interdisciplinary, but that the disciplines for mathematics to work with depend on the challenge.

## 7.5 Closing

EPSRC tends to see things as either training or research, whereas a mathematician would tend to use “and”. GCRF is clearly thought of as “research”. But we are hearing ODA countries speak much about training. JHD raised the South Korean example (as exemplified at 2014 ICM).

### 7.5.1 INI

David Abrahams noted that EPSRC grant has just been renewed, but with an emphasis now on inclusivity rather than exclusivity, and more about the impact of mathematics. Long programmes, 20K participant–day/year. Roughly 1/3 UK, 1/3 Europe and 1/3 RoW. Also workshops within programmes, and 7K participant–day/year. 77 nationalities, but 18 at 1 participant.

**Q** It would be really neat if the Mekong River Commission could launch an INI Challenge.

### 7.5.2 ICMS

There are various UK centres training centres, e.g. Manchester’s MAGIC, Scotland’s SMTC (?). How can we give access to these to ODA countries — e.g. associate membership. But ICMS’s own format is research, usually very focused workshops (this has been an exception). Typically 18 months from proposal to submission. But the (rapid response) strategic workshops are one page of A4 for a case, where the opportunity/need is time-limited. Both ICMS and INI have “follow-on” money. INI follow-on can happen elsewhere, often ICMS, but one has been in Vienna. Typically 1 year after,