Mathematical Sciences for Development

Appendices A-F

Appendix A: GCRF Day 2 Health Report

GCRF Reporting:

Day 2

Theme: Health (equitable practice and epidemiology)

Participants (including day visitors): Honora Smith (Southampton), Wirichada Pan-ngum (Mahidol-Oxford), Goylette Chami (Cambridge), Mike Tildesley (Warwick), Tiejun Ma (Southampton), Wilfred Ndifon (AIMS Africa)

Leaders: Honora Smith, (Deidre Hollingsworth – in absence, due to snow!)

Talks/Discussion: Honora Smith, David Abrahams

What GCRF research topics were covered by the talks, discussion session and conversations?

(1) Equitable organisation and allocation of scarce resources in healthcare:
- Location of health facilities
- Supply chain and logistics in healthcare
- Matching of kidney donations to recipients
- Matching of staff resources to (less desirable) locations

(2) Societal issues and health
- Forecasting societal implications of the ageing population (University of Southampton, Centre for Gerontology).
- Risk taking in purchasing healthcare insurance
- Death from road traffic accidents

(3) Infectious disease control and prevention
- Infectious diseases are an important cause of mortality in DAC List countries
- Numerous examples of infectious disease modelling for infectious disease control
  - Neglected Zoonotic Diseases (NZDs) ; (Zeeman Institute, University of Warwick)
  - Neglected Tropical Diseases (NTDs); (Neglected Tropical Diseas Modelling Consortium, Big Data Institute, Oxford; Wellcome Trust Cambridge Centre for Global Health Research (WT-CCGHR))
  - water-borne diseases; HIV/AIDS, TB, Malaria, Measles; –
- Used for prediction of disease spread, optimising multi-phase control policies
- Number of mathematical problems which underlie the applied need.

What examples of previous success (either in application of the science or in GCRF proposals) were described?

Equitable provision of resources

- Mathematical programming for location of HIV/AIDS test laboratories in South Africa: CD4 alone and a hierarchy of tests in a hub network.
- Mathematical programming, simulation-optimisation and stochastic programming for supply chain and logistics in the blood supply chain in Thailand and Colombia: location of facilities, vehicle routing for distribution of scarce perishable blood products
- Statistical risk modelling for optimal location of disease monitoring sites in Africa
- Funding just granted by MRC/CONFAP Brazil, Newton Fund, collaboration between social sciences and Operational Research/Management Science: EU QUERO, improving mother and infant healthcare provision for the first 1000 days of life (includes "soft OR" – problem structuring, and some data envelopment analysis).

Infectious disease modelling for better targeting of control:

- human deaths from rabies, mapping (EPSRC GCRF institutional award)
- modelling of NTD/NZD, leptospirosis, habitats of rodents (Newton-Royal Society award)
- Dynamic modelling of population growth and diabetes – melioidosis transmission model
- Prediction of disease spreading – H5N1 avian to human transmission
- Social network analysis, network-based algorithm for targeting lay health workers in mass drug administration for NTDs
- Modelling seasonal variations in transmission to optimise deworming programmes for children (EPSRC GCRF institutional award).

What new areas were discussed in detail and how will these help DAC list countries directly?

Healthcare data management - in situations of incomplete or handwritten health data sources in DAC list countries (DfID - Tanzania)

- Record linkage,
- Data/text mining
- health data quality
- eliminating fraudulent insurance claims,

Usage of mobile phone data in healthcare –DAC List countries may be ahead in using mobile phone technology where cabled services are beyond reach.

- for disease monitoring, including sector integration of monitoring of animal to human infections
- for optimisation of data collection
- for arranging micro-finance
- for diabetes treatment (Brazil – epilepsy/brain)

Social determinants of disease etc., in particular conditions of DAC list countries

- social networks – seeding interventions
- lifestyle effects

- complex diseases (AIMS Ghana - monitoring)

Personalised medicine
Novel drug use targeting – could be cost efficient
Indigenous production of medical instrument or accessories for affordability
Clinical imaging – for diagnostics in remote communities
- CAT scans
- Remote diagnostics, e.g. mobile phone images

Vaccine design and effectiveness (EBI – data dimensionality)
- antigen mapping

In conjunction with other sustainable development goals
- disease spread prediction, healthcare burden of environmental shocks and disaster management
-

Health is a hidden driver of a number of the sustainable development goals. The links between health and these goals is also an area of ongoing research.

What research topics are likely to produce good GCRF proposals? Where possible, which geographical locations will this help most and are there particular groups in the UK and DACL list country partners which would be able to undertake this research?

Healthcare data management – a general need in less developed areas of DAC list countries. The University of Southampton Centre for Operational Research, Management Science and Information Systems (CORMSIS), with expertise in both healthcare modelling and data mining, is collaborating with the National Health Laboratory Service (NHLS) of South Africa and the University of the Witwatersrand (Wits) for data/text mining in situations of incomplete or handwritten data sources. A proposal is being developed for data imputation to enable targeting of interventions to improve diagnosis of ethnic groups with increased burden of diseases, such as prostate cancer among black males in South Africa.

Equitable provision of resources: CORMSIS has wide-ranging expertise in healthcare modelling, including optimisation techniques and simulation, as well as 'soft' OR skills such as problem structuring. CORMSIS members, in research led by Social Sciences, are partnering with Brazilian universities in the recently announced MRC/CONFAP awards, for better utilisation of maternity-infant resources in districts with poor health provision.

Infectious disease modelling for better targeting of control – there are particular needs in Sub Saharan Africa, but generally throughout the DAC list countries. The Wellcome Trust Cambridge Centre for Global Health Research (WT-CCGHR), part of The University of Cambridge Cambridge-Africa Programme, is helping to establish UK-African partnerships for research. With hubs in Ghana and Uganda, there is collaboration with 30 African host institutions. Scientific questions for research arise from African researchers, in areas such as targeted health interventions and tailoring medical treatments.

Infectious disease modelling: the Mahidol Oxford Tropical Medicine Research Unit (MORU) is a research collaboration between Mahidol University, Bangkok, Thailand, the University of Oxford and the Wellcome Trust (UK), with studies across Thailand, Asia and Africa. Research areas in which

mathematical modelling can play an important role include diagnosis and treatment of malaria and neglected tropical diseases such as melioidosis, typhus, TB and leptospirosis.

Infectious disease modelling: the neglected tropical disease modelling consortium (www.ntdmodelling.org), an international team of infectious disease modellers from 12 institutions working across nine neglected tropical diseases (e.g. sleeping sickness, river blindness, intestinal worms), is based at the Big Data Institute, University of Oxford (www.bdi.ox.ac.uk). The consortium is mainly funded by the Bill and Melinda Gates Foundation, who support the highly applied nature of their work. There are a number of mathematical problems which this team identify as they are addressing the applied questions, which would be amenable to a more analytical approach. This team have developed a number of collaborations with epidemiologists, biological researchers and policy-makers in DAC list countries and are looking for ways to collaborate more fully both with these groups and with mathematical researchers in these countries.

AIMS – African institute of mathematical sciences – could be an important potential partner on the mathematical side.

Were there any other conclusions (scientific perspectives, new potential collaborations outside GCRF, etc)?

Opportunities for more mathematics: There is a long history of UK mathematical modelling, statistical inference and data science research in applied health sciences. In the context of GCRF, there are multiple needs for these analyses to inform the application of current tools, the development of new tools and the optimisation of responses to improve health, which is an important driver of development in DAC list countries. Within these highly applied aims, it is important to note, that there are important mathematical questions underlying these applied research aims, as the examples discussed today demonstrate but opportunities to take a more analytical approach are sometimes missed in the drive to deliver the applied result.

Working with mathematicians in DAC list countries: When working with DAC list countries, it's also important to note that there are a number of strong mathematical researchers, as well as bio-medical researchers, who would like work with the UK in a way which supports those mathematical researchers as well as developing new collaborations with the bio-medical researchers.

Developing new collaborations: In terms of identifying the questions which are mostly urgently needing to be addressed, or developing new collaborations in DAC list countries, the current mechanisms are not ideal for building new collaborations. Many of the collaborations funded under GCRF are based on existing collaborations, as these have a high chance of successfully delivering the aims and make for stronger, synergistic applications.

Strengthening the role of mathematical research in GCRF: Overall, we would like to see

- better communication between the more applied and the more theoretical ends of our fields, nationally and internationally, so that the best mathematical minds can be brought to assist in the efforts to support DAC list countries in achieving better health.
- novel mechanisms for identifying important questions and developing new collaborations.

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Appendix B: GCRF Day 3 Energy Water Governance Report

GCRF Reporting template:

Day 3

What GCRF research topics were covered by the talks, discussion session and conversations?

Energy, Water, Governance (and Networks)

Day Leaders: Apala Majumdar (Bath) and James Davenport (Bath)

What examples of previous success (either in application of the science or in GCRF proposals) were described?

1) Dr Ian Griffiths (Oxford) and Dr Mondal (currently at Oxford and will take up a faculty position at IIT Kharagpur from April 2018) collaborated with Professor De's group at IIT Kharagpur on removing arsenic from water in India (and other countries in South-East Asia) and designing efficient filters with a relatively long lifetime. This work was funded by a GCRF grant, followed by Royal Society funding etc. This work has been awarded a MPLS Impact Award by the University of Oxford.
2) Apala Majumdar (one of the organisers for Day 3) had contacted Professor Phillip Maini (Chair of Mathematical Biology, University of Oxford) about his work on HIV modelling in India.
3) Professor David Mond (Warwick) nominated that Majumdar and Davenport contact a researcher from DEFRA and Professor Arya (IIT Roorkee) suggested that the organisers contact a professor at the University of Sheffield for a case study with researchers in engineering, based in India. Majumdar & Davenport are pursuing these contacts.

What new areas were discussed in detail and how will these help DAC list countries directly?

[1] Existing portfolio of contacts between UK researchers and researchers in DAC List countries.

ZED-I group in Bath has extensive contacts in India along with good contacts in South Africa, Sri Lanka, Egypt and Botswana.

Mondal has contacts with Cameroon and Thailand, South Africa.

Alf Onshuus offered to partner UK people with relevant researchers in Colombia, Equador and Costa Rica.

Majumdar has extensive contacts in China, India, Chile and Mexico.

Davenport has contacts with the ZED-I group, Lesotho and Thailand.

[2] Existing infrastructure.

The mechanisms for bilateral research came across very clearly in the case of India, where there are specific programmes for inviting foreign researchers and bilateral Indo-UK projects. Colombia has funding for sending students abroad for Ph.D. degrees but no systematic routes for research funding, as far as we could tell. The mechanisms appear to be lacking in Zimbabwe and Botswana.

[3] What would like out of GCRF funding?

- a database of contacts of UK researchers and researchers in DAC List countries
- funding for large research networks
- training of graduate students, opportunities for students from DAC list countries to spend time in the UK
- real need for knowledge exchange and capacity building
- specific areas for collaborative work: climate models, flood and drought models, urban planning, disaster management, disease modelling, analysis of large data sets, uncertainty quantification
- there is specific phenomenon of moisture capture by plants in Colombia (and other mountainous tropical regions) which has received little attention and is in need of mathematical modelling; could be an excellent GCRF project (Onshuus contact)

- producing documents for stake holders

- outreach and dissemination strategies at a broad level

What research topics are likely to produce good GCRF proposals? Where possible, which geographical locations will this help most and are there particular groups in the UK and DAC list country partners which would be able to undertake this research?

- Majumdar, Mondal, Chris Budd and Professor Sarkar (Jadavpur University) will work on a GCRF networking application based on climate change models in the context of India.
- Urban planning
- Water filtration
- Flood, drought and agriculture-based models
- Healthcare
- New materials for the future

Were there any other conclusions (scientific perspectives, new potential collaborations outside GCRF, etc)?

Isabel Moya (Zimbabwe) has contacted Professor Arya (IIT Roorkee) and wishes to apply for a C.V.Raman Fellowship to gain research experience in India. This contact was established during the GCRF workshop.

Majumdar and Davenport recommend that GCRF networking grants would be an excellent way of improving the linkage and would ensure the sustainability of the links from this workshop. A mailing list, seeded from the members of this workshop, would be very helpful.

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Appendix C: GCRF Day 4 Climate and Environment Report

GCRF Meeting

Theme: Climate and Environment (Day 4)

Participants (including day visitors):

Leaders: Annunziata Esposito-Amideo and Tristan Pryer

What GCRF research topics were covered by the talks and conversations?

Intractable Challenges Preventing DAC list Countries Sustainable Development

1. **Disaster-related issues**

- Flooding:
    - There are flood risk maps in the UK. Are there similar tools elsewhere? In South America there are.
    - Flooding in river deltas.
    - Control of flooding through dam structures. Hydro power associated to the downstream consequences. What is the balance there?
- Extreme weather/climate events:
    - Increasing in frequency due to global warming.
    - Prediction and mitigation.
- Prediction of landslides:
    - People build their houses in no-go areas with no governmental consent/planning permission.
    - Critical regions are ascertained by the potential population effected in the first instance.
    - This could be related to the 'hind casts' of landslides around volcanoes by some groups in Bristol, Manchester, and Cambridge.
    - These can be related to UK problems with mud-streams in large steep valleys in the UK.
- Multiscale data:
    - These inputs are subject to uncertainty (e.g., monsoon).
- Impact of urbanisation:
    - Land use change through overpopulation.
    - Social modelling.
- Humanitarian supply chains resilience, infrastructure design and risk management.
- Economic perspectives (e.g., social cost evaluation).

2. Data-related issues

- Data acquisition/retrieval:
    - Data access, quality, and availability.
    - Data management tools.
    - Data type (e.g., disaster, infrastructure, demographics, social media).
    - Correlation algorithms for climatological data.
    - Identification of hottest parts in case of droughts.
    - Scaling issues (upscaling/downscaling and uncertainty related to these processes).
    - Not only rainfall data but also different other kinds of climatological data.
- Data assimilation techniques:
    - Observations typically used in data analysis and data assimilation are unreliable or sparse in nature.
    - There are new sources of data in DAC list countries, developing countries have a huge number of mobile phone users, for example.
    - Air pollution is mainly driven by urban areas and extreme events that experience surges in their frequency, forced by climate changes.
    - Dynamical model outputs in order to detect extreme events.
    - Development of cheap data sampling devices/usage of satellite data.

3. Forecasts and forecast related issues

- Forecast/Prediction
    - Short/medium/long-term
    - Historical data VS global models
- HPC facilitation for numerical modelling.
    - Simulating large scale physical systems, such as atmospheric and ocean models, can be inherently very expensive. Recently, the sheer scale of these simulations is beginning to reach a limit dictated by the power consumption of the data centres in which the computations occur.
    - DAC list countries may not have reliable (or any) access to HPC facilities. Is there the possibility of facilitation through shared computational power?
    - 'Smart' algorithms/pre-processing of data to avoid the need for HPC.

4. Informing Decision- and Policy-Making

- Strategic level (e.g., relief centres location).
- Tactical level.
- Operational level (e.g., evacuation routes under disruptive circumstances).
- Land use dynamics.
- Network and dam design.
- Need to translate the mathematics in an understandable manner for policy makers, it should be 'different but not distant'.
- Different risk perception across DAC list countries.
- Public outreach.

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What examples of previous success (either in application of the science or in GCRF proposals) were described?

- AIMS (African Institute for Mathematical Sciences) – train people to go away with generic skills.
- MUII programme - Cambridge links with Uganda and other sub-Saharan African countries for epidemiology study.
- "CliMathNet" http://www.climathnet.org/ which has been running since 2013 and aims to increase dialogue between mathematics and climate sciences.
- EPSRC LWEC network "Maths Foresees: mitigating severe environmental events" www1.maths.leeds.ac.uk/mathsforesees/
- SIAM Maths of Planet Earth activity group http://www.siam.org/activity/mpe/
- MPE centre for doctoral training http://www.mpecdt.org/
- International Workshop On Mathematics Of Climate Change And Natural Disasters. Brazil, funded through the Newton Fund. http://www.lac.inpe.br/cciarm/
- Risk visualisation and quantification for disaster risk reduction. UCL. NERC.
- Satellite-Based Rainfall Estimates In Weather Based Index Insurance (SATWIN) Microensure. University Of Reading. NERC.
- Operation Probabilistic Flood Forecasting Model Of The Karnali River Basin In Nepal. Lancaster University. NERC.
- A Near Real Time Aftershock Forecasting Tool For Humanitarian Risk Assessment And Emergency Planning Concern Worldwide / University Of Ulster. NERC.
- Trialling Analysis Of Eruptive Scenarios Via Economic And Probabilistic Approaches On Tristan Da Cunha, And Its Application To Decision Support Foreign And Commonwealth Office / British Geological Survey / University Of East Anglia. NERC.

[What new areas were discussed in detail and how will these help DAC list countries directly? What research topics are likely to produce good GCRF proposals? Where possible, which geographical locations will this help most and are there particular groups in the UK and DAC list partners which would be able to undertake this research?

Opportunities for Mathematical Sciences within each challenge macro-category

1. **Disaster-related issues**

- Mathematics of flooding: PDE and numerical modelling, probabilistic applications, control theory.
- Landslide modelling – Uncertainty analysis. Input of hydrological models are the met forecasts. How would ensemble methods propagate through the model?
- Urbanisation – There is no mathematical theory governing this at the moment. Various opportunities in network analysis, for example (https://www.ucl.ac.uk/bartlett/casa/about-us/software/space-syntax). Need for INDC (carbon) reduction.

2. **Data-related issues**

- Stakeholders involvement: in order to make an impact, relevant stakeholders such as WFO, NGOs, and local organization acting in DAC list countries need to be involved since the very early stage of the project.
- Soft Operational Research (OR) skills can fit the purpose (e.g., problem structuring methods, system dynamics) as well as another further branch which is Behavioural OR (very recently deployed towards the analysis of social media data within disaster management)
- Data science and harmonisation of different data sources.
- Machine learning can be used to reduce the computational complexity. We need to develop tools to turn data into actionable information.
- HPC facilitation through shared computational power.

3. Forecasts and forecast related issues

- Geospatial models along with hybrid (hydrology/meteorology/seismology) models to foster the accuracy of the short/medium/long-term forecast of disaster data.
- Time-forecasting models along with extreme value theory to evaluate in detail the dynamic evolution of disastrous events, (in particular, multivariate extremes are not well understood).

4. Informing Decision- and Policy-Making

- Disaster Management Cycle (DMC): different problems can be tackled according to the DMC phase we decide to focus on. Examples are: mitigation (e.g., resource allocation for network design), preparedness (e.g., early warning systems, shelter location), response (e.g., evacuation planning), recovery (e.g., debris clean-up).
- Scenario-based modelling – the uncertainty related to disaster opens to stochastic as well as scenario-based modelling; in particular, the evaluation of different scenarios within a single modelling framework can lead to the identification of an overarching robust solution to be adopted.
- Dynamic optimization – dynamic optimization tackles another aspect related to disasters, their temporal evolution. In fact, the on-set of a disaster is very different from its evolution which can dramatically affect the infrastructure conditions. Moreover, also resource availability is time-dependent.

DAC List Countries involved in day 4: Brazil, Malaysia, Cambodia, Lao PDR.

The challenges and opportunities are easily extendable to other DAC list countries in South America (Chile, Venezuela, Peru, Columbia) and South/South East Asia (India, Bangladesh, Thailand, Myanmar, Vietnam).

Research Groups in the DAC list countries who have expertise in the challenges:

- Brazil: Centro Nacional de Monitoramento e Alertas de Desastres Naturais (CEMADEN) for natural disaster monitoring, São Paulo State University (UNESP), Instituto Nacional de Pesquisas Espaciais (INPE).
- Cambodia: Royal University of Phnom Penh for some optimization aspects.
- India: Indian institute of Technology Roorkee for water and climate modelling.

- Malaysia: School of Environment and Natural Resource sciences and the National University of Malaysia for climate modelling.
- Lao PDR: National University of Laos for dynamic optimization.

Research Groups in the UK who have expertise in the challenges: Bios document enclosed.

Were there any other conclusions (scientific perspectives, new potential collaborations outside GCRF, etc)?

- Training and capacity building as well as public outreach: International Centre for Doctoral Training, Post-doc cohort, PhD studentships, and ECR support for knowledge transfer exchange between UK and DAC list countries. Mathematics can especially contribute to the GCRF agenda when viewed as an "enabling technology". Advanced mathematical training can in many ways enable DAC list countries to tackle problems in ways that do not involve being reliant on external experts. Higher mathematics does not require extensive infrastructure, in the ways that say microelectronics or biotech does, just human resources, training and access to a library.

- "Institute of development mathematics" a centre for innovation that is placed in a DAC list country, for example in East Asia as a hub for training and research. Distributed centres allowing for exchange of ideas, knowledge management through postdocs/PhDs.

- Need for a multi-disciplinary approach where mathematics forms the foundations. In particular, climatology, meteorology, hydrology, seismology, operational research can all be deployed with the ultimate goal of developing a Decision Support System. As an example:

    - Stakeholders can be involved through Soft OR approaches in order to get data.
    - Data of different sorts can be analysed through climate and related-models.
    - Data can be improved through forecast analysis given specific statistic expertise.
    - Data can be used as input parameters for a specific optimization models tackling one of the issues arising from one of the DMC phase.

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Appendix D: GCRF Meeting Participants and Output Distribution List

List 1: Meeting Participants

	Surname	First Name	Institute
1	Abrahams	David	Isaac Newton Institute for Mathematical Sciences
2	Arya	Dhyan Singh	Indian Institute of Technology Roorkee
3	Ashwin	Peter	Reading
4	Bektas	Tolga	University of Southampton
5	Bokhove	Onno	Leeds University
6	Bortolozo	Cassiano	CEMADEN, Brazil
7	Chami	Goylette	University of Cambridge
8	Chansomphou	Vatthanamixay	Faculty of Environmental Sciences, National University of Laos
9	Crisan	Dan	Imperial College London
10	Davenport	James	University of Bath
11	Dent	Christopher	University of Edinburgh
12	Dunne	Patrick	ESSA - Education Sub Saharan Africa
13	Esposito-Amideo	Annunziata	Kent Business School
14	Gimperlein	Heiko	Heriot-Watt University
15	Glendinning	Paul	ICMS, University of Manchester
16	Gondzio	Jacek	University of Edinburgh
17	Greetham	Danica Vukadinovic	University of Reading
18	Grindrod	Peter	University of Oxford
19	Hazelwood	Vera	Smith Institute
20	He	Runan	Heriot-Watt University
21	Hines	Adrian	Met Office
22	Hollingsworth	Deirde	University of Oxford
23	Kirkilionis	Markus	University of Warwick
24	Kotiadis	Kathy	Canterbury Christ Church University
25	Lodge	Matthew	EPSRC
26	Lucarini	Valerio	University of Kent
27	Ma	Tiejun	University of Southampton
28	Madzvamuse	Anitoda	University of Sussex
29	Majumdar	Apala	University of Bath
30	Mauk	Pheakdei	Royal University of Phnom Penh
31	McCullen	Nick	University of Bath
32	Mond	David	University of Warwick
33	Mondal	Sourav	University of Oxford
34	Morupisi	Kgomotso	University of Bath
35	Moyo	Isabel	National University of Science and Technology, Zimbabwe

36	Natarajan	Sukumur	University of Bath
37	Ndifon	Wilfred	African Institute of Mathematical Sciences
38	Neumann	Frank	University of Leicester
39	Nicholson	Jane	EPSRC
40	O'Cleary	Neave	University of Oxford
41	Onshuus	Alf	Universidad de los Andes
42	Pan-ngum	Wirichada	Mahidol-Oxford Tropical Medicine Research Unit, Mahidol University, Bangkok
43	Pryer	Tristan	University of Reading
44	Ramsden	Stephen	University of Nottingham
45	Ray	Surajit	University of Glasgow
46	Roberts	Mark	University of Surrey
47	Santos	Leonardo	CEMADEN
48	Schroers	Bernd	Heriot-Watt University
49	Shuckburgh	Emily	British Antarctic Survey
50	Smith	Honora	University of Southampton
51	Stern	Roger	University of Reading
52	Stockford	Chloe	Imperial College London
53	Tangang	Fredolin	National University of Malaysia
54	Tildesley	Michael	University of Warwick
55	Tran	Trung Hieu	University of Nottingham
56	Vanneste	Jacques	University of Edinburgh
57	Vargas	Patricia	Heriot-Watt University
58	Wingate	Beth	Exeter University
59	Zografos	Konstantinos	Lancaster University

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List 2 – Meeting Output Distribution List (in addition to participants), e.g. Advisory Committee Members, Invited Participants unable to attend, input to initial review etc.

	Surname	First Name	Institute
1	Akartunali	Kerem	University of Strathclyde
2	Andres	Felipe Osorio Muriel	Universidad Icesi
3	Ashby	Deborah	Imperial College
4	Champeneys	Alan	University of Bristol
5	Chen	Bo	Warwick Business School/OR Society
6	Church	Jenny	RSS working group
7	Cotter	Colin	Imperial
8	Dawes	Jonathan	University of Bath
9	Diggle	Peter	Lancaster
10	Donnelly	Christl	Imperial College
11	Dr Isambi	Mbalawata	South Africa
12	Edmunds	John	LSHTM
13	Etheridge	Alison	University of Oxford
14	Ferguson	Neil	Imperial College
15	Foupouagnigni	Mama	University of Yaunde I
16	Glazebrook	Kevin	University of Lancaster
17	Green	Barry	AIMS
18	Griffiths	Ian	Univeristy of Oxford
19	Gupta	Pradeep	India
20	Howick	Susan	University of Stratclyde
21	Huang	Huaxiong	Fields Institute
22	Isham	Valerie	University College London
23	Jara	Alejandro	Chile
24	Lester	Christopher	University of Oxford
25	McGinty	Sean	University of Glasgow
26	Medley	Graham	LSHTM
27	Megiddo	Itamar	University of Strathclyde
28	Milewski	Paul	University of Bath
29	Moline-Paris	Carmen	Leeds
30	Mujumdarppm	Pradeep	Indian Institute of Science Bangalore
31	Nokes	John	Kenya
32	Nyabadza	Farai	Stellenbosch
33	Pamen	Olivier	Liverpool
34	Paola Scaparra	Maria	Kent Business School
35	Roth	Cathy	DfiD
36	Roy	Rahul Roy	Indian Statistical Institute, New Delhi
37	Saizmaa	Tsogzolmaa	University of Bath
38	Sammonds	Peter	UCL
39	Silal	Sheeta	South Africa

40	Stern	David	University of Reading
41	Stewart	Theo	University of Cape Town
42	Szendroi	Balazs	Univesity of Oxford
43	Theo	Stewart	University of Cape Town/Manchester
44	van Greunen	Darelle	Nelson Mandela Metropolitan University
45	Velani	Sanju	University of York
46	Wemyss	Michael	University of Glasgow
47	White	Leroy	Warwick Business School
48	Wilson	Alan	ATI
49	Zemkoho	Alain	University of Southampton

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Appendix E: GCRF Directory – Draft 1

	Last_Name	First_Name	University	Country	Email	Research Interests/Areas of Expertise
				(blank=UK)		
1	**Arya**	D S	Department of Hydrology, IIT Roorkee	India	dsarya@gmail.com	Water and climate modelling. Case I - in hydrology, data is assumed stationary and random. Under the climate change scenario, this very assumption is challenged and hydrological modelling tools are needed new methodology and techniques. So, there is scope for mathematician to work and design tools and techniques. Case II - there is a scope for creating new information, methods etc. for hydro-comatic services in the Himalayan region following problems are important: large data set available but have different temporal and spatial resolution. So, upscaling/downscaling is required to bring data to a common scale. Bring data to common scale introduces uncertainty which must be addressed. Newer search algorithms are required to identify and predict extreme events using these large data sets as mentioned above. Very simple analysis leading to study of climate change/variability may also be attempted. New modelling tools may be designed to accept these large gridded data set as inputs rather than the point data inputs.
2	**Bortolozo**	Cassiano	CEMADEN, Brazil	Brazil	cassianoab@gmail.com	My research interests are related to geophysical modelling an inversion, electromagnetic methods, mass movements prediction and slope stability. My expertise is related to electromagnetic methods modelling and inversion, joint inversion of geophysical methods, hydrogeology and mass movements (landslides)

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3	**Chami**	Goylette	Department of Pathology, University of Cambridge		gjc36@cam.ac.uk	Global health • Geographical focus is sub-Saharan Africa; key study sites- Lake Victoria & Lake Albert in Uganda • Identification of morbidity attributable to human helminthiasis (worms) and methods to improve large-scale treatment campaigns • Targeted delivery of global health interventions • Computational medicine • Complex networks: social networks, spatial, transmission, and comorbidity networks • Randomised-controlled trials, quasi-experimental analyses • Artefactual/behavioural experiments Global health • Geographical focus is sub-Saharan Africa; key study sites- Lake Victoria & Lake Albert in Uganda • Identification of morbidity attributable to human helminthiasis (worms) and methods to improve large-scale treatment campaigns • Targeted delivery of global health interventions • Computational medicine • Complex networks: social networks, spatial, transmission, and comorbidity networks • Randomised-controlled trials, quasi-experimental analyses • Artefactual/behavioural experiments
4	**Chansompho u**	Vatthanamixa y	Faculty of Environmental Sciences, National University of Laos	Laos	vatthanamixay@hotmail.com	I'm interested in using mathematical models for analysing the issues of development and the environment. More specifically, it is the use of mathematical models and analysis such as: general equilibrium analysis, dynamic optimization, differential equation, time series and econometric analysis and operation research tools to study about development planning, environmental impact of economic development, the impact climate change tec.
5	**Esposito-Amideo**	Annunziata	Kent Business School		ae306@kent.ac.uk	doctoral activity concerning the development of novel optimization models and solution methods for disaster management. Research focus on evacuation planning and critical infrastructure protection.
6	**Glendinning**	Paul	ICMS, University of Manchester		p.a.glendinning@manchester.ac.uk	Pure and applied dynamical systems. Includes biophysical applications and piecewise smooth systems

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7	**Kirkilionis**	Markus	University of Warwick		mak@maths.warwick.ac.uk	Mathematical modelling - interest in the general applicability of mathematical modes, including philosophy of science aspects. Interest in the interface of mathematical modelling with data science, machine learning, artificial intelligence and computing (HPC). mathematical biology - all aspects of applications of mathematics to the Life Sciences, including bioinformatics and Image analysis. Numerical Analysis interest in transforming mathematical modes into numerical simulations.
8	**Madzvamuse**	Anitoda	University of Sussex		A.Madzvamuse@sussex.ac.uk	Research interests - mathematical modelling based on experimental observations, analysis (mathematical & numerical) of mathematical models. Numerical analysis and simulations, HPC scientific computing, Data fitting and parameter identification. Areas of expertise, cell motility/cell migration, spatio-temporal models (ODEs & PDEs), numerical algorithm development, pattern formation, wound healing.
9	**Mauk**	Pheakdei	Royal University of Phnom Penh	Cambodia	pheakdei@gmail.com	operational research/applied probability and statistics: mathematical modelling of microcredit to investigate the behaviour of interest rate in microcredit lending
10	**Morupisi**	Kgomotso Susan	University of Bath		ksm32@bath.ac.uk	Dynamical systems, mathematical modelling. Using mathematical modelling to predict the amount of rainfall that can be received by certain areas. Also to come up with models that can depict how climate change effects food production or agriculture in Botswana.
11	**Moyo**	Isabel	National University of Science and Technology, Zimbabwe	Zimbabwe	ilzulu82@gmail.com	Financial modelling using Bayesian networks. Reliability models (markov chains), econometric modelling and multivariate analysis, time series analysis. Mentoring students/life coaching. Also considering climate change modelling and its impact on our economies, i.e. agriculture, tourism, sustainability.

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12	**Ndifon**	Wilfred	African Institute of Mathematical Sciences		wndifon@nexteinstein.org	Theoretical biology - using data and mathematics to understand the mechanisms that govern immune response to diseases. Applications, including improved diagnostics and vaccines. Examples of projects on - using math modelling (ODE-based) to explain surprising aspects of immune responses to infections such as original antigenic sin, What is health? Developing a quantitative definition and measure of health
13	**Neumann**	Frank	University of Leicester		fn8@le.ac.uk	Research interests - pure mathematics (algebraic geometry, algebraic topology, number theory). I am especially interested in the arithmetic, geometry and topology. I am a board member for the LMS-IMU-AMMSI initiative mentoring African Researchers for Mathematics (MARM) and I was a mentor for the programme at KUUST, Ghana. I am a board member for the EMS Committee for Solidarity
14	**Pan-ngum**	Wirichada	Mahidol-Oxford Tropical Medicine Research Unit, Mahidol University, Bangkok	Thailand	pan@tropmedres.ac	I am a mathematical modeller with interests in neglected tropical diseases and zoonotic infections. I have been using maths models to tackle health problems specifically arising in the region (Leptospirosis, dengue, malaria). I am keen on capacity building and enjoy training local modellers
15	**Roberts**	Mark	University of Surrey		M.Roberts@surrey.ac.uk	Previous research - dynamical systems, Hamiltonian system & applications. Current research - population genetics. Other relevant experience - work in higher education in Africa. Leadership of postgraduate training programmes.
16	**Santos**	Leonardo Bacelar Lima	CEMADEN, Brazil	Brazil	santoslbl@gmail.com	time varying geographical complex networks: rainfall, drainage, soil moisture, hydrological modelling (empirically), disaster's impact on urban mobility and epidemiology (dengue, yellow fever, leptospirosis)
17	**Scappara**	Maria Paola	Kent Business School, University of Kent			Application of optimization techniques to critical infrastructure protection planning, disaster management and humanitarian logistics among others.

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18	**Stern**	Roger	University of Reading		r.d.stern@reading.ac.uk	Improving teaching of statistics. The analysis of historical climate data.
19	**Tangang**	Fredolin	National University of Malaysia	Malaysia	tangang@ukm.edu.my; ftangang@gmail.com	My research interest covers climate variability (ENSO, Monsoon, IOD, MJO, various mesoscale phenomena such as cold surges, Borneo vortices) and Climate change. Expertise regional climate modelling, model data analysis. I also provide leadership in the region in trying to build up capacity in regional climate modelling in the Southeast Asia region through the Southeast Asia Regional Climate Downscaling (SEACLID)/CORDES Southeast Asia. I am also interested in regional oceanography, regional ocean and wave modelling
20	**Vargas**	Patricia	Heriot Watt University		p.a.vargas@hw.ac.uk	my area of expertise is robotics and computer science, more specifically building intelligent controllers for robots within a wide range of applications, from healthcare, energy, surveillance, neuroscience, space, environment, agriculture, monitoring. We use a plethora of bio-inspired algorithms, computational intelligence, machine learning, deep learning, reinforcement learning, computational neuroscience and evolutionary computation

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Appendix F: GCRF and UK Mathematical Sciences Meeting Programme

Programme

Day 1: Overview of DAC, emerging and existing themes, capability

Organisers: Susan Howick, David Mond, Mark Roberts

Monday 26 February 2018

Time	Activity
09.30-10.15	**Meeting Registration** Meet and Greet (Coffee and Tea)
10.15-10.30	Welcome and Introductions (Paul Glendinning/David Abrahams ICMS)
10.30-11.30	EPSRC Perspective on GCRF (Matthew Lodge, EPSRC)
11.30-12.30	Experience of being involved with a GCRF project and lessons arising for the maths community (Peter Grindrod, Oxford)
12.30-13.30	Lunch
13.30-14.30	Opportunities and challenges for Maths research in LMIC countries. (Wilfred Ndifon, and other DAC list country participants)
14.30-15.00	Coffee break
15.00-16.30	Introduction to Discussion Session (Mark Roberts) Discussion Session – Forum to discuss topics arising on the day and the capability issue in further depth
16.30-17.00	Any other emergent issue and closing remarks
17.00-17.30	Prepare Summary Slide to feed into Days 2/3/4
17.45-19.15	Evening Buffet

Day 2: Healthcare (equitable practice and epidemiology)

Organisers: Deirdre Hollingsworth, Valerie Isham, Honora Smith

Tuesday, 27 February 2018

Time	Activity
09.15-09.45	Meet and Greet (Coffee and Tea)
09.45-10.15	Introductions and planning for the day
10.15-11.00	Presentation on Operational Research (OR) for healthcare resource planning in DAC list countries – reporting on application of several different modelling approaches
11:00-12:15	Presentations on Infectious disease modelling for DAC list countries
12.15-13.15	Lunch
13.15-13.30	Introduction to afternoon activities
13.30-14.15	First Round of Discussions: e.g. "Linking Challenges and Approaches"
14.15-14.45	Presentations of groups' discussions
14.45-15.00	Coffee break
15.00-15.45	Second Round of Discussions: e.g. "GCRF Schemes: which mode fits each country and each challenge"

15.45-16.15	Presentations of groups' discussions
16.15-16.30	Any other emergent issue and closing remarks
16.30-17.00	Final document assembly
17.45-19.15	Evening Buffet

Day 3: Economy (water supply, energy, networks, sustainability, governance)
Organisers: James Davenport, Apala Majumdar
Wednesday 28 February 2018

Time	**Activity**
9.15-9.45	Meet and Greet (Coffee and Tea)
9.45-10.30	Introductions, Input from Day 1, Planning for the day.
10.30-11.00	DAC list country perspectives and background. Short presentations from participants
11:00-11.30	Coffee Break
11.30-12.00	Skype talk from Neave O'Cleary (Oxford)
12.00-12.30	DAC list country perspectives and background ctd
12.30-13.30	Lunch and Discussions
13.30-14.15	First Round of Discussions: Breakout session on research in water, energy, networks and governance in the UK and DAC list countries.
14.15-14.45	Presentations of groups' discussions
14.45-15.15	Coffee break
15.15-15.45	Second Round of Discussions: GCRF – opportunities and networks
15.45-16.15	Presentations of groups' discussions
16.15-16.30	Any other emergent issue and closing remarks
16.30-17.30	Final document assembly
17.45-19.15	Evening Buffet

Day 4: Climate and Environment (environmental shocks, disaster management)
Organisers: Dan Crisan, Maria Paola Scaparra
Thursday 01 March 2018

Time	Activity
09.15-09.45	Meet and Greet (Coffee and Tea)
09.45-10.30	Introductions, Input from Day 1, Planning for the day.
10.30-12.15	DAC list perspectives and background. Short presentations from participants 1. Prof. Fredolin Tangang (National University of Malaysia) 2. Leonardo Santos (CEMADEN) 3. Antonio Bortolozo Cassiano (CEMADEN) 4. Vatthanamixay Chansomphou (National University of Laos) 5. Pheakdei Mauk (Royal University of Phnom Penh)
12.15-13.15	Lunch and Discussions
13.15-13.30	Introduction to afternoon activities
13.30-14.15	First Round of Discussions: "Linking Challenges and Approaches"
14.15-14.45	Presentations of groups' discussions
14.45-15.15	Coffee break
15.15-15.45	Second Round of Discussions: "GCRF Schemes: which mode fits each country and each challenge"
15.45-16.15	Presentations of groups' discussions
16.15-16.30	Any other emergent issue and closing remarks
16.30-17.00	Final document assembly
17.45-19.15	Evening Buffet

Day 5: Write Up and Reporting
Friday 02 March 2018

Time	Activity
09.15- 09.45	Meet and Greet (Coffee and Tea)
09.45-10.30	Informal discussion of main themes and feedback from each day, highlighting anticipated conclusions and recommendations.
10.30 – 12.00	Working in groups on meeting write up and other associated tasks.
12.00-13.00	Lunch and Discussions
13.00-14.00	Working in groups ctd
14.00-14.45	Informal catch up on write up and associated actions progress.
14.45-15.00	Meeting wrap up
15.00	Meeting Close