## Appendix 1 Advisory Group for the Workshop

The advisory group was set up to provide advice and steer the development of a workshop on urban simulators for water in cities in March 2016.

Members include:

Dr Jim Wharfe – Independent – Chair of the Advisory Group & the Workshop
Dr Kevin Smith – STFC - Sponsor
Tony Rachwal – Tony Rachwal & Associates
Dr Adam Cambridge – Atkins
Stephanie Bricker – BGS (also Future Cities Catapult)
Dr Mike Jones – Thames Water
Robyn Thomas – NERC Innovation
Richard Coutts – BACA - Architects
Prof Brian Collins, UCL (UKCRIC)
Prof Mike Batty, CASA, UCL

Project Manager: Hazel Jeffery

## Appendix 2 Scope of the Workshop

The result of discussions and comments from the Urban Simulators Advisory Group is captured below, which informed the workshop in March.

### 1. Desired outcomes for urban simulators for water and their relationship with demonstrators

i. A sound understanding of current UK and overseas capability on simulators and demonstrators and their transferability with particular regard to water.
ii. A clear outline of how existing urban simulation capability will support economic growth targets, delivery efficiencies, improve citizen welfare, and the level of investment required to support this during demonstration testing.
iii. An assessment of the potential for further development of what exists and where new integration is viable.
iv. Identified opportunities to exploit existing data models more effectively (eg. STFC, NERC, CEH, BGS, Water Utilities, EA, Met Office).
v. An understanding of the practicalities & constraints (technical, usability, cost, legislation and regulation) and the barriers & enablers for improving the take up of urban simulators in practice.
vi. A realistic understanding of the value of water in the urban context and potential gaps in the research landscape that could improve this.
vii. Identified key user drivers that will allow ultimately useable outputs at a range of levels from technical through to high level decision-making.
viii. Presenting strategic options at appropriate scales and resolution – local, catchment, regional, temporal – with appropriate visualisation.
ix. Guidance on the use of simplified / complex models (tiered/structured).

## 2. Aims of the workshop

The workshop will bring together expertise around urban simulators and demonstrators for water, to discuss:

- What current capability and capacity exists in the UK context?
- What are the key drivers and challenges for users in developing urban simulators for water?
- What research is being done in this area already, and where can the Task Force add value?
- What research questions need to be addressed and which of these may be best answered by simulators?
- How will simulators need to interact with demonstrators? For example: what supporting evidence could demonstrators provide; and, the trialling of findings from simulators in a demonstrator environment.
- Who will use the simulators or the outputs of simulators for water and how will they be used?
- What resources will be required (people, hardware, software, data etc.)?
- Where are the opportunities for funding the development of simulators to better manage water related issues (particularly flooding, water scarcity and societal benefits)?
- Development of an action plan for the next steps in taking this area forward.

## Appendix 3 Urban Simulators for Water Workshop – Participants

| Name | Organisation |
|---|---|
| Jonathan Abra | KTN Ltd |
| Marcus Ambler | Mfatech Limited |
| Mike Ashworth | STFC |
| Joby Boxall | University of Sheffield |
| Louise Bracken | Durham University |
| Stephanie Bricker | British Geological Survey |
| David Butler | University of Exeter |
| Adam Cambridge | Atkins |
| Alison Clark | Defence Simulation Centre |
| Alex Collins | Imperial College London |
| Brian Collins | UCL (University College London) |
| Richard Dawson | Newcastle University |
| Quillon Harpham | HR Wallingford |
| Jill Holden | AGMA/GMCA |
| Peter Holt | Arup |
| Hazel Jeffery | Independent |
| Mike Jones | Thames Water |
| Simon Jude | Cranfield University |
| Stuart Kirk | EA & Defra |
| Majdi Mansour | British Geological Survey |
| Geoff McBride | STFC |
| Ana Mijic | Imperial College London |
| Bruce Napier | BGS |
| Ian Page | Defence Simulation Centre |
| Nicholas Paling | Westcountry Rivers Trust |
| Anne Priest | NERC |
| Tony Rachwal | UK Water Partnership |
| Stefano Rolfo | STFC |
| Dragan Savic | University of Exeter |
| Kevin Smith | STFC |
| Jim Wharfe | UK Water Partnership |

## Appendix 4 Workshop Agenda and Process

# Urban Simulators for Water Workshop – 16-17 March 2016

| Wednesday 16 March 2016 | |
|---|---|
| **12.00 – 12.45** | *Lunch available* |
| **12.45 – 13.05** | Welcome to the Hartree Centre, STFC – Mike Ashworth<br>Introduction – UK Water Partnership - Jim Wharfe |
| **13.05 – 13.45** | Visualisation demonstrations:<br>• Bruce Napier, BGS – Geovisionary<br>• Stefano Rolfo, STFC |
| **13.45 – 14.40** | Case studies:<br>• Adam Cambridge - Atkins<br>• UK Collaboratorium for Research in Infrastructure and Cities – Brian Collins<br>• Demonstrators – David Butler<br>• Defence Simulation – Ian Page & Alison Clark<br>• Analysis of Urban Simulators – Geoff McBride<br>• Questions |
| **14.40 – 15.15** | (A) Break-out groups (3-4 stakeholder groups)<br>Each group will tackle the same question:<br>What are the 3 priority issues to be addressed? |
| **15.15 – 15.30** | *Refreshment break* |
| **15.30 – 15.45** | Break-out groups (continued) |
| **15.45 – 16.25** | Plenary discussion:<br>• Feedback from each group on the priority issues. |
| **16.25 – 17.15** | (B) Break-out groups:<br>For each priority issue:<br>• Where are we now? What needs to be done to tackle the issue? |
| **17.30** | *Transport to Hotel* |
| **19.00** | *Dinner at the Ring O'Bells, Chester* |

| Thursday 17 March 2016 | |
|---|---|
| **08.15** | *Transport from hotel to Daresbury* |
| **09.00 – 09.30** | Review the first day – bringing it all together. |
| **09.30 – 10.30** | (C) Break-out groups:<br>Drafting time – putting detail on the workshop outputs & highlighting where further information is required. |
| **10.30 – 10.50** | *Refreshment break* |
| **10.50 – 11.20** | (C) Break-out groups:<br>..continued.. |
| **11.20 – 12.00** | Plenary discussion<br>• Building the case for urban simulators. What else is needed?<br>• Next steps |
| **12.00 – 12.45** | *Lunch and depart* |

## Appendix 5 Workshop Outputs

**Session A -** ***What are the 3 priority issues to be addressed by urban simulators?***

**Group A – Research/modelling**

1. What is the need? What are the questions?
    - Need to justify funding. What, how, why?
    - Co-creation, multi-sector, tests, demos
    - Range of applications & different levels of complexity.
    - Supply chain resilience
2. Interdependencies
    - Topographies of networks (digital, people, knowledge)
    - Sector interdependencies eg. Science & engineering
    - Types eg. Function, info, spatial, cascade of risks (failure points), application for planning
    - Scale – temporal, spatial
3. Uncertainty in data models
    - Evidence and risk management
    - Improvement by unpicking failure in reverse (Comms, KE)
    - Confidence in the iteration of simulators
    - Compatibility
    - Public acceptance
    - Transparent process
    - Understanding the limitations.. and what is possible
    - For exploration of Futures – urbanisation and scenarios – not for definitive forecasts/predictions
    - Data (quality / IPR)

**Group B – Research/modelling**

1. Integration of surface and ground water, rural and coast
    - Need to get away from silos, can't manage flooding or water supply without knowledge & underground infrastructure.
    - Take into account the role of SUDS – subsurface and atmospheric interactions
2. People – integrating them into simulators
    - human behaviour, socio-economics & decision-making
    - making decisions on a large scale
    - processes – model / visualisation
    - upscale – city, country
    - communication & decision-making – visualisation, how to use them?
3. Catchment simulator
    - Would encompass: surface, ground, coastal, infrastructure, flooding etc.
    - Cities close to the coast, integration of rural and urban – catchment to sea
    - Need to be clear on the questions
    - Different agendas & interests, and different timescales for decisions.
    - Could be done in 10 years.
    - Needs integration & a multi-partnership working towards a common framework
    - Different applications
    - Visualisation – use at an early stage to understand the problem and get different disciplines together
    - Database with all the information will be required

- BIM subsurface information – building models

4. Research & knowledge underpinning the urban simulator product
    - E.g. Time-stepping
    - Interface & ability to add extra models / modules
    - Understand the limitations of the simulators and assumptions
    - E.g. River and groundwater model connection takes years. Technical implementation
    - Need standards – to share data
    - Need to develop / innovation
    - Data + models
    - Nesting of models – small & high resolution or large & low resolution
    - Longer term – seasonal variability, unknowns, different conceptual uncertainties, flexible decision-making for the future
    - Proprietary vs open data – big data
    - Thames Water shortfall in supply – move to metering
    - Integrate with other sectors e.g. Emergency planning, cost/benefit of critical infrastructure
    - Water-energy-food nexus
    - Flooding debris – integrate building models. When a building collapses it changes the water flow.
    - Impact – getting the data – water companies will not release data which is needed for research models
    - Central database for research
    - Need to fund the boring development phases too.

**Group C - Government and policy**

**Problems**

- Perception – need a clear vision for significant differences to the urban environment
- Growing risks – climate change, population growth, water management
- Lack of a systems approach to cities. Need to break down silos. Can't see the potential until we integrate.
- Include energy?
- Optimal balance to deliver benefits to communities and local economics
- Lack of coordination and joining up

**Failures**

Coordination failures occur at government, agency & local level. The following should help.

**Simulation**

3 types of simulation required to address different scenarios. Options so that you can turn different dials. Collective decision making.

1) within urban areas – options to improve water management with socio-economic benefits, especially impoverished communities. Defra project is making in-roads (W71580) – Using Soft Green Infrastructure Solutions i.e. Retrofitting.

2) Look at all the different types of solutions – softer and harder engineering and technological. Understand what the options are – optimum combination.

3) Whole catchments – add more dials to green infrastructure, technological improvements. We add: landscape improvements, agricultural changes. What are the cost/ benefits of all the scenarios?

**Audience**

- Speak to all the different groups
- Core model – technically robust
- Scalable approaches, different outputs for different audiences

| |
|---|
| **Benefits**<br>• Safer, more secure place to live….improved well-being and local economies. |
| **Group D - Business**<br>**Water and other utilities** (energy) and future city planners<br>5-25-50 year integration scenarios for investments planning & operational efficiency<br>**Consulting sector** – (service)<br>Natural integrator – environment – risk – physical – economics – response training<br>Global market – future cities – water – investment<br>Good links academia to customer<br>**SMEs** – fast innovation<br>Need demonstrators to sell to consultants / Tier 1 end user<br>**Insurance** / investor sector – model investment and risk<br>Plug and play modules in grand framework of city / regional / community / home scale |

## Session B – Who is it for?

Purpose

- 1 product or many?
- Who pays / invests?
- Audiences (education, engineering)
- Governance / business?

Do we find something that could be funded by many organisations?
Customers

- Operators
- Investor / designers
- Academics
- Non-paying customer – is the public

Does the simulator have to be a model?

## Session B – How is it used?

Interface

- what do they want?
- What ifs / optioneering
- Visualisation
- Standard outputs

Results
Behavioural optioneering – hard/soft solutions
Budget – steers the level of information
Uses depends upon user's need
Choose a user & determine what they need
Human interface with infrastructure – needs to
Central database to link all available models with the holders
Simulator isn't the end goal. Its results are.
Simulators rely heavily on the person to obtain info, bring together & tailor the results to the user's needs.
Data integrity is key
Metamodels

**Barriers**

- Commercial IPR
- Data formats – public – private
- Data integrity
- Overall coordination / standards
- Budget steers resolution / size

**Opportunities**

- Joining of the silos
- Cost savings
- Skilled people needed
- Central directory of models

## Session B - Architectures

Includes functions, dependencies, uncertainties, human factors

**NOW**

- Generally standards and architectures for model integration, visualisation – though too many
- Millions of models
- Problem with take-up / acceptance of which standards & frameworks
- Uncertainty / too many options
- Legacy & dependencies to ensure utility of legacy

**Going forwards**

Risks – paralysis – picking the wrong one

Opportunities

- international
- Citizen science e.g. Kickstarter
- Identify criteria for arch/ framework
- Critical mass of data for validation

Barriers

- Prejudices
- Do we have the required skill sets
- Understanding of the system
- Developing existing products
- Scale – size, temporal differences
- Will functionality fit into one framework
- 1 million + 1 options

Enablers

- Computational Power
- Community ownership
- Advances in relevant technical areas eg. AI
- Developing existing products
- Bringing together the brains of the community

## Session C - Vision

**Statements**:

1. Our vision is to enable people to think differently about water use to develop water resilience

2. To develop a visualisation tool to allow people to experiment different scenarios to be able to understand and behave differently

Education, i.e. informing and engaging public and politicians
Training

- Specific events response
- Simulate future problems, for example floods and droughts
- Learn from military
- Gaming, Visualisation

Link to translate research into practice
Ability to play with a City. Having a framework that allow decision makers to perform possible scenarios (climate, policies), e.g. Malmo.
Decision support:

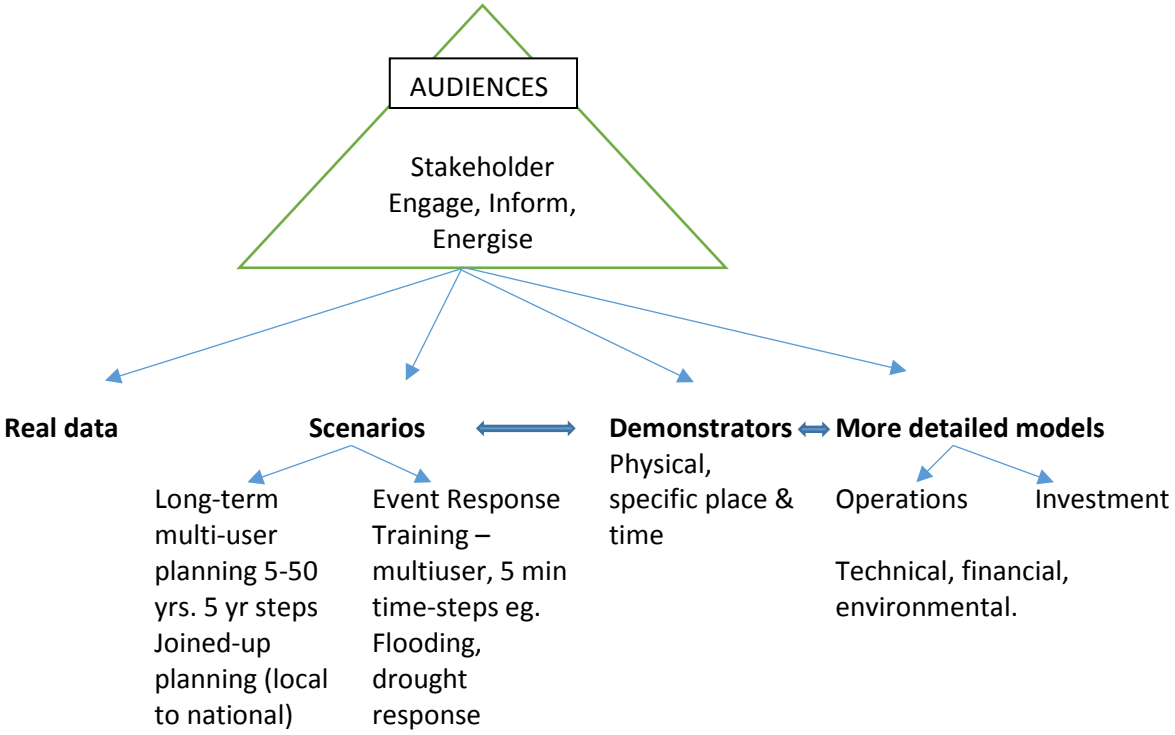
- Operation
- Design
- Planning

What are the rest of the world doing/planning to do (eg. Malmo)? What could UK expertise add to what is already there?
Joined planning. Who is in charge? and who is informed?

**We need to specify what exactly we are trying to answer. Each use case needs financial analysis.**
**Examples of future user questions for simulator environments:**

- Integration of groundwater and surface water to meet city water supply and enhance flooding resilience.
  - How do natural and built environment impact on this question
- During flooding events how does flooding affect transport, energy, critical infrastructure and services.
- Joined-Up Planning – local to national. What are the scenarios and possible interactions, threats, risks & consequences for decisions on infrastructure planning on 5, 25, 50 year horizon:
  - Water resources
  - Reservoirs, groundwater
  - Flood alleviation
  - Urban population change, behaviour change
  - Climate change
  - Buried network renewal/ Road access
- UK strategy for water infrastructure

**Component Levels**




Text: Could all the multiple players use the simulator on a short or long term?
"Play" at high level with a city.
Simulator is not a detailed science/engineering model, emulator
What are the benefits of having the Simulators/Demonstrators?

- VALUE OF WATER & Interactions with society, infrastructure, well-being & environment is UNDERSTOOD, Planned for , resilient, fundable, affordable.

<u>Next steps – possible actions</u>

- The need for small set of scoping projects involving academia, SMEs, big players. Generic 'big' picture is broken down to achievable, fundable, foundation projects. Engaging stakeholders in specific cases studies.
- Literature and current R&D funded by EU, USA, etc. What can UK add to urban simulators
- What is already coming e.g. integrators, game sector, military sector
- Link a UK demonstrator and simulator proposal?
- Fund/run a hackathon on concepts, e.g. event response scenario training
    - Involve gaming industry, military simulators
    - Invite multi-sector agencies : water utilities, city, EA, emergency response
- Market (UK, Global) value of urban model/simulation/visualisation now-2020-2025
    - Ask consultants, model service sector, end user
    - Justify investments in R&D (£1ms, £10ms)
- Explore global sustainable development goals role for simulators, potential new UK funding route
- Fund a video on "what if I could…", 3 to 5 minutes to promote, explore stimulate interest in the possibilities. Should be aiming at a wide audience not just technical people.

## Session C - Drivers/Needs

Decision-making – different timescales, take into account different interests eg. On planning infrastructure, or making policies.
Risk management failures
Communicating to different audiences – need a common language
Uncertainties
Avoid lock-in to models (need to use new tech/data/code)
Value creation for different stakeholders e.g. Consultancies, SMEs. Not just software, also maps and data.
Money – time-saving, therefore Cost/Benefit.
Business:

- case for industry buy-in
- who is going to pay for it?
- Links with sectors: insurance, finance, energy, transport, telecommunications, people

Key customers include: Water companies; Defra; Local authorities; Environment Agency; UKWIR; Insurance; Consultant – development / construction; Operators; Designers / planners; academics.
Ability to play with a city

- Simple concepts
- Basic concepts – detail can follow later

Driver: understanding the semantics of models to enable linkage – understanding inter-change & the semantics between models modules.

## Session C - Research & Innovation

Unique selling points:

- Integration
    - within water and other infrastructure
    - between models and software
    - include human aspects (trusted intermediary)
- Enhanced delivery of integrated information
- Confidence / trusted – best and latest algorithms

Phase 1 – Challenge-led urban– tactical, strategic, urban / rural
Phase 2 – Generic Model Platform – including uncertainty framework, interfaces, decision analysis Transparency, nature of coupling (loose, tight, dynamic), support
Phase 3 – Next generation simulators– respond to challenges & provide integrated decision-making

Some tools may be ready for use. May need to adapt others / include new middle steps for integration.
Stakeholders

- co-create challenges / identify added value from integration
- middleware market as innovation space
- provide existing models – testing
- interpretation & use of 'integrated urban water simulators', & exploring trade-offs between costs and benefits
- demonstrators & living labs for validating / real world experimentation
- learning processes
- new business models / partnerships

What are the rest of the world are doing? What could UK expertise add to what is already there?