IDENTIFYING THE EXPECTED IMPACTS OF CREDO

EXECUTIVE SUMMARY

30 March 2022

The Centre of Digital Built Britain (CDBB) at the University of Cambridge has worked with a number of partners, including three asset operators – Anglian Water Services, BT and UK Power Networks – to develop the Climate Resilience Demonstrator CReDo. CReDo is a climate change adaptation digital twin project aimed at improving resilience across infrastructure networks. CReDo also contributes to the development of and shows how the Information Management Framework (IMF) approach can enable data sharing across connected digital twins in a scalable way.

FLOODS ARE LIKELY TO HAVE A SEVERE IMPACT ON THE INTERCONNECTED SYSTEM OF UTILITY ASSETS

Electricity, water and telecoms assets are owned and operated separately, but they form an interconnected system. This means that the failure of one asset, for example in the event of a flood, can cause assets of other operators to fail. For example, electricity substations provide power to water and wastewater pumping stations and telephone exchanges; cooling water systems can be used to remove waste heat from telephone exchanges; and telephone lines are installed at electricity substations where a mobile telephone signal cannot be received.

Flooding can cause failures to utility assets, which can propagate through the system. This results in costs to asset operators as well as service interruptions and associated costs for customers. For example, the Environment Agency estimated that the total economic damage of the winter floods of 2015 and 2016 to asset operators (electricity and water) and their customers was more than £100m.[1] Because of climate change, the likelihood of these potentially damaging floods is expected to increase over the next century.

CREDO CAN HELP ADDRESS A KEY INFORMATION BARRIER PREVENTING INVESTMENT IN SYSTEM RESILIENCE

Asset operators invest in their assets to ensure that they are resilient to climate change, including floods. Asset operators understand their own networks and, when deciding whether and how to invest in resilience, they take account of a number of factors. These include how critical each asset is for their networks and the financial resources they have available for resilience investment.

It is unlikely that asset operators have complete information on 1) the resilience of other operators' assets on which their assets depend or 2) how critical their assets are for other operators. For these reasons, investment decisions may not be as cost effective across the system as they could be. For example, an asset operator may decide not to invest in a specific asset because it is not critical for its network, not knowing that it may be critical for another asset operator's network. It may also decide to increase the resilience of one of the assets which is critical for its network, not knowing that the other asset operators' assets on which

[1] EA (Jan 2018), *Estimating the Economic Costs of the 2015 to 2016 Winter Floods.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672087/Estimating_the_economic_costs_of_the_winter_floods_2015_to_2016.pdf .

its assets depend are already resilient. Hence, there is an information barrier that prevents asset operators from assessing the resilience of the whole system and making investment decisions accordingly.

The combination of a system-wide view of infrastructure resilience provided by CReDo and improved information management is expected to lower the information barrier. Frontier Economics was commissioned by CDBB to identify the expected impacts of CReDo and provide a simulation of the subset of potential social benefits related to flood resilience.

CREDO IS EXPECTED TO BRING A RANGE OF BENEFITS TO ASSET OPERATORS AND THEIR CUSTOMERS

Table 1Figure 1 below sets out a logic model for CReDo. It maps out the outputs, outcomes and impacts that we identified and expect to flow from CReDo relative to a counterfactual scenario.

The expected impacts of CReDo include those that relate directly to the current application of CReDo to flood resilience, those that relate to the enabling role of the IMF and the potential spillover impacts that flow from one or both of these. Impact beneficiaries are divided into three broad groups: asset operators, residential and business customers, and wider society.

The comparison relative to a counterfactual enables us to trace which of the impacts from CReDo would not be expected to materialise in its absence. We focussed on understanding how CReDo can enable a system-wide view of infrastructure resilience and improve information management. Therefore, in the counterfactual scenario, we assumed that individual asset operators do not have a tool to enable a system-wide view of infrastructure resilience and do not use a common information management system across sectors. Instead, we assumed that asset operators will (at some point in the future) use digital twins of their own infrastructure to inform resilience activities.

FIGURE 1 A LOGIC MODEL OF CREDO

INPUTS	OUTPUTS	OUTCOMES		IMPACTS		
• Data from collaborators • Resource and time costs (CReDo team and asset owners) • Data platform	• Credo digital twin with use case for East Anglia	• Improved understanding of interconnectedness • Improved planning • Improved response ***Leading to*** • Reduced number and/or duration of outages	FLOOD RESILIENCE	**ASSET OWNERS** • Reduced cost/more effective flood resilience • Reduced cost of repairs from/cost of response to flooding events • Reduced regulatory penalties	**COMMERCIAL CUSTOMERS** • Avoided loss of income • Avoided damage to commercial assets/property **RESIDENTIAL CUSTOMERS** • Avoided damage to properties • Avoided loss of income • Avoided injuries, deaths and mental health issues	**WIDER SOCIETY** • Increased resilience of essential infrastructure (schools, hospitals etc) • Reduction in flood related contamination/pollution • Improved resilience decision making
• Information Management Framework (IMF)	• Demonstration of application of IMF	• More efficient/effective ways to share information between organisations	INFORMATION MANAGEMENT	**ASSET OWNERS** • Reduced cost of data sharing • Increased willingness to share data • Improved decision making	**RESIDENTIAL/COMMERCIAL CUSTOMERS** • Lower costs of providing services or improved quality of service	**WIDER SOCIETY** • Faster development/reduced cost of developing other digital twins • Improved potential for collaboration across sectors • Improved environmental and social outcomes
			SPILLOVERS	• Progress discussion on climate change modelling • Better quality data • More accessible data		

Source: Frontier Economics

OUR SIMULATION OF POTENTIAL BENEFITS PROVIDES AN INITIAL, BUT PARTIAL VIEW OF THE ORDER OF MAGNITUDE OF BENEFITS LIKELY TO BE ASSOCIATED WITH CREDO

CReDo is an innovative demonstrator project still in the relatively early stages of its development. Given this, it has been necessary to rely on a version of CReDo with synthetic data to simulate potential benefits. This version of CReDo is an abstract from the digital twin. Synthetic asset data has been created by the CReDo project team to protect the confidentiality of the asset data under the terms of the data licence. The synthetic data was created to be representative of the type of assets and connections between assets found in the asset data. This version of CReDo with synthetic data is limited to simulating the impact of a single surface water flood event in a stylised area of East Anglia, assumed to be home to approximately 10,000 people. The level of resilience modelled depends only on the connections between the assets; CReDo does not currently take into account resilience provided by other mitigation strategies, such as on-site or mobile generators, batteries, satellite communication systems. The infrastructure modelled is assumed not to change over the next 30 years.

This version of CReDO provides only a partial view of the potential benefits of CReDo. It is partial in terms of the impact of different types of flooding events in the stylised area, the source of resilience modelled, and in terms of being able to robustly scale the impact in the hypothetical area to other areas of the country. For example, this version of CReDo does not model the impact of other types of flooding event, e.g. coastal or fluvial floods, nor of storm-related factors, such as wind, nor of other types of extreme weather events, such as heatwaves. As a demonstrator project, the role of scaling is particularly important as it is through scale that substantial benefits tend to be unlocked.

These limitations mean that, at this stage, it has not been possible to provide robust estimates of the potential benefits that CReDo can generate. Instead, we present a conservative and partial simulation of the potential benefits associated with scaling the impact of the surface water flood event in this version of CReDo with synthetic data. Data limitations also mean that our simulation is limited to the impact of CReDo on *planning* for resilience (excluding flood response benefits) and is limited to a subset of the benefits identified in our logic model. We focus on the benefits to asset operators and customers associated with improved flood resilience, excluding wider societal benefits, benefits associated with the IMF and any spillovers. For these reasons, our simulation of the potential benefits is likely to underestimate the potential benefits of CReDo for increasing resilience to any type of flooding events across the infrastructure system.

Despite these limitations, our results show that, based on the sensitivity analysis performed, this subset of simulated benefits is worth between £6 and £13 million across East Anglia over 2022-2050, and between £81 and £186 million across the UK over the same period. In our central case, this amounts to a simulated public return on investment (related only to the simulation with synthetic data) of 23:1 over 2022-2050. As mentioned above, these results are not robust estimates of the potential benefits, but a *simulation* of potential benefits. The results are presented as ranges to reflect the significant uncertainty in the estimates. An important dimension of this uncertainty relates to the probability of occurrence of the storm event causing the flood in the version of CReDo with synthetic data in any given year to 2050. The ranges of the benefits reflect different probability of occurrence (increasing from 0.5% in 2022 to 1% in 2050; constant at 1% per year; increasing from 1% in 2022 to 2% in 2050).

TABLE 1 SIMULATION OF EXPECTED SOCIAL BENEFITS – (2022-2050, £M 2022 CONSTANT PRICES)

SCOPE	LOWER SIMULATION (PROBABILITY OF OCCURRENCE OF FLOOD: 0.5% TO 1%)	CENTRAL SIMULATION (PROBABILITY OF OCCURRENCE OF FLOOD: 1% CONSTANT)	UPPER SIMULATION (PROBABILITY OF OCCURRENCE OF FLOOD: 1% TO 2%)
East Anglia	£6m	£8m	£13m
UK	£81m	£117m	£186m

Source: Frontier Economics
Note: The figures in the table represent a weighted average of the simulated benefits for different counterfactual scenarios.

The main body of this report provides details of our simulation, the assumptions that we made, sensitivity analysis, and suggestions on how this methodology could be refined to provide more concrete estimates of benefits as CReDo is refined.

It is significant to note that the grossing up of simulated benefits for East Anglia relies on assumptions, based on evidence wherever possible and conversations with asset operators and the CDBB team elsewhere, about: 1) which parts of East Anglia have assets at risk of floods; 2) which investment decisions asset operators may take; 3) that by the end of 2024, CReDo will enable the prediction of the impact of floods across the whole of East Anglia and will include some refinements which will ensure that its predictions can be used for decision making; and 4) that the regulatory regime will allow asset operators to co-invest in system resilience from 2029. Similar assumptions are used to simulate benefits for the UK. There is a further assumption that, by fulfilling its potential as a demonstrator, asset operators in other parts of the country are incentivised to develop their own regional versions of CReDo. These incentives could be direct from regulators or an indirect reflection of the reputational damage caused by a lack of such investment.

We understand that CReDo could also be developed to consider the impact of other types of climate change related weather events (e.g. heatwaves). The expected impacts of using CReDo to increase resilience to a range of weather events are expected to be larger than the benefits of increasing resilience to surface water floods. Once a more advanced version of CReDo is finalised, we recommend that quantification of the expected impacts of CReDo be undertaken again.

HOW TO USE THE FINDINGS FROM OUR STUDY

This study contributes to the understanding of the potential benefits of CReDo through the development of a logic model and theory of change of CReDo and the simulation of some of the potential benefits. The methodology used in the simulation can be applied to evaluate future versions of CReDo.

The logic model of CReDo identifies the potential benefits of CReDo for both asset operators, their customers, and wider society. This framework can be useful throughout the CReDo decision-making process, for example, supporting decisions about which outputs of CReDo to prioritise to achieve the target benefits.

As noted above, CReDo is a demonstrator project still in the relatively early stages of its development. We did not attempt to evaluate CReDo. Instead, we simulated the impact of some of the potential benefits of CReDo. Our simulation is partial and conservative. As such, the results of our simulation provide a conservative preliminary indication of the order of magnitude of benefits that CReDo could be expected to generate. The methodology underpinning our results can be adapted and refined to form the basis of a more detailed evaluation of a future version of CReDo.