ICTs and Climate Change Adaptation: *Enabling Innovative Strategies*

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As the impacts of climate change intensify, developing countries must implement innovative strategies to adapt to changing climatic conditions and uncertainty. Information and communication technologies (ICTs) can play a key role in strengthening adaptive capacity. This Brief identifies ICTs' contribution to national adaptation strategies (e.g. NAPAs) and to specific sectoral adaptations in developing countries.

It argues that ICTs provide generic support to the process of information-gathering, decision-making, implementation and evaluation for national-level adaptation. Specific ICT applications enable delivery of particular adaptational actions for the vulnerabilities that climate change affects including poverty, water, agriculture and food security, human health, terrestrial and marine ecosystems, and disaster management among others.

The Brief concludes by identifying guiding principles for use of ICTs in adaptation processes, suggesting that their role goes well beyond the use of climate-specific applications. The informational, productive and transformational potential of ICT tools must be harnessed and designed with a holistic, integrated view of adaptation; one that looks at the complete 'info-system' of mobile phones, Internet applications, telecentres and mass media to foster adaptation at the national, sectoral and community levels.

Adaptation within Vulnerable Contexts

Faced with the unprecedented challenges posed by climate change, developing countries are starting to address the need to adjust and adapt to new, and often uncertain climatic conditions.

Climate change adaptation is a process by which "strategies to moderate, cope with and take advantage of the consequences of climate events are developed and implemented"[1]. Within complex developing environments, these processes cannot be understood or addressed in isolation from other development stressors. Climate change and other shocks such as economic crises and conflict are mediated through a set of vulnerabilities – financial, social, political, etc – that communities face; vulnerabilities that in turn create constraints to adaptive capacity[2].

Knowledge and information play a key role in overcoming such constraints, and are pivotal for building and strengthening the capacity of multiple stakeholders involved in adaptation strategies at the micro, meso and macro levels. Information and communication technologies (ICTs) - the Internet-based applications, mobile phones, telecentres, community radio, etc that are increasingly available in developing regions – provide an exceptional opportunity to improve the creation, management, exchange and application of relevant climate change information and knowledge. They should also be recognised for their productive and transformative capabilities.

[1] UNDP (2004) *Adaptation Policy Frameworks (APF) for Climate Change: Developing Strategies, Policies and Measures*, Cambridge University Press http://www.undp.org/climatechange/adapt/apf.html#about
[2] Prasad, L., & Heeks, R. (2011) *ICT-Enabled Development of Capacity for Climate Change Adaptation*, Centre for Development Informatics, University of Manchester http://www.niccd.org/PantHeeksClimateChangeAdaptationICTs.pdf

ICTs & Climate Change Adaptation Strategies

Climate change adaptation can be planned or emergent. While the latter refers to spontaneous actions taken by actors affected by climatic stimuli or events, planned or policy-driven adaptation processes involve the formulation of strategies that consist of a general plan of action, including policies and measures, for addressing climate change impacts within a given context[3]. The reach of adaptation can be national, sectoral or local, and its formulation is context-specific (e.g. dependent on climatic risks and vulnerabilities, adaptive capacities, policy context and stakeholders' support).

Thus, the role of ICTs in climate change adaptation can be explored at three main levels: national, sectoral and local/community level, as reflected in Figure 1.

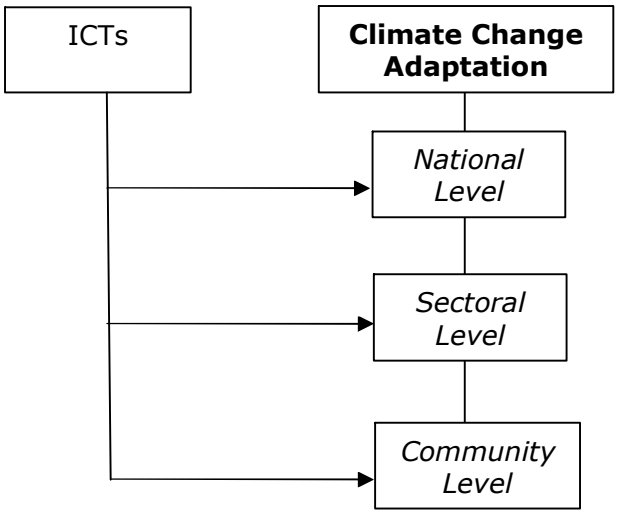

Figure 1. Relation Between ICTs and Climate Change Adaptation

This Brief focuses on the linkages between ICTs and adaptation at two levels: (a) national adaptation plans, based on the different stages involved in their formulation, and (b) sectoral strategies, based on the key areas affected by climate change (poverty, water, agriculture and food security, health, disasters, etc)[4].

(a) ICTs & National Adaptation Plans (NAPAs)

The formulation of national adaptation plans or strategies – often known as, or formulated from, National Adaptation Programmes of Action (NAPAs) – involves different activities aimed at producing an effective policy framework to reduce the country's vulnerability to current and future climatic threats. Based on the model developed by UNDP[5], those activities can be categorised into three main stages:

1. Gathering of information and synthesising available knowledge about the current and future state of climate change and adaptation requirements.
2. Design of the adaptation strategy, including making decisions about what adaptation measures to undertake.
3. Implementation of the adaptation strategy, including evaluation of the impact of that strategy.

From this perspective, ICTs can contribute to the formulation of NAPAs/national plans in five main domains, as reflected in Figure 2.

[3] UNDP, op.cit.
[4] The linkages between ICTs and community-based adaptation will be explored in a separate NICCD Strategy Brief.
[5] Ibid.

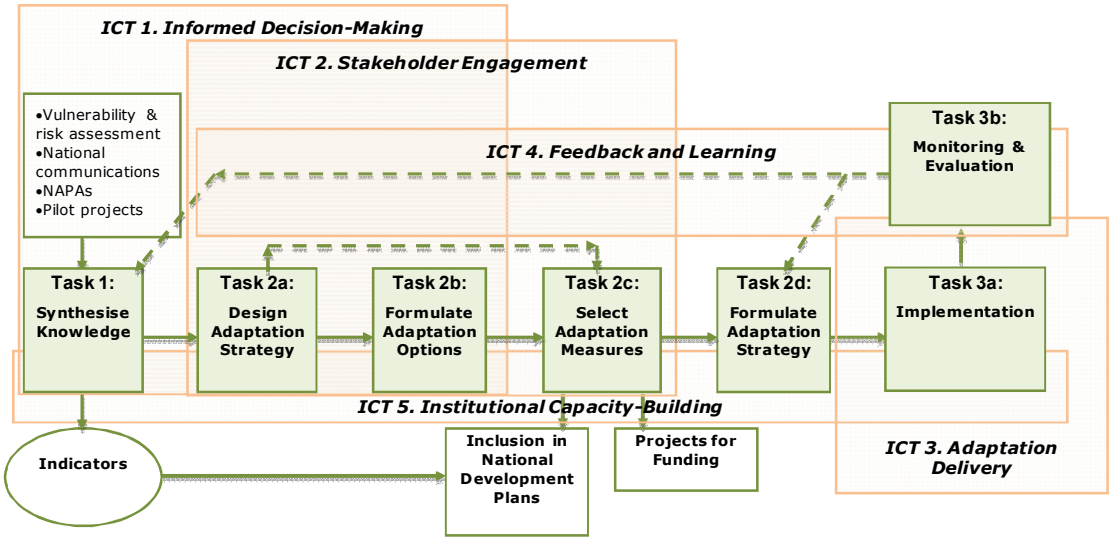

Figure 2. ICTs and Formulation of an Adaptation Strategy (adapted from UNDP 2004)

1. Informed Decision Making

Within complex developing contexts, the creation of adaptation plans is an information-intensive activity. Knowledge and information inputs from diverse sources can help to inform decision-making processes by identifying the specific needs and priorities at the local and national level, as well as the vulnerabilities, resources and capacities available in support of adaptation processes. ICT applications such as geographic information systems (GIS) and meteorological information systems can help to understand both the current extent of climate change, but also to model future impact on not just weather but also agricultural productivity, health and disease, disaster incidence, etc. Simpler ICT tools like email and web-enabled databases can draw in a wide range of information and knowledge perspectives (presented in appropriate languages and user-friendly formats). ICTs can also support planning and decision-making processes by helping to localise adaptive actions and to strengthen the capacity of local actors to analyse climate models and predictions.

2. Stakeholder Engagement

The formulation of adaptation plans requires a partnership between public, private and civil sectors. ICTs can facilitate the inclusion of multiple voices in the design of adaptation strategies at various levels, from simple broadcast and awareness-raising of issues to be decided; to fuller engagement through the use of social media and online polling of those likely to be affected; to the use of group decision-support systems to model and analyse different scenarios, and enable decisions to be made. GIS applications, earth browsers, and Web-based clearinghouse sites are offering possibilities for citizen monitoring and accountability, strengthening the public's support and engagement in the implementation of adaptation strategies. Likewise, Web 2.0 tools (e.g. social networking sites, Wikis and blogs), smart phones (mobile phones with Internet capabilities, allowing text and audio-visual data sharing) and online discussion fora (such as the Adaptation Learning Mechanism, ALM)[6], are fostering new forms of engagement and participation in climate change adaptation and crisis response. Thus ICTs are helping foster dialogue and exchange for participative planning through applications for remote collaboration, online networks and forums that help to converge and mobilise stakeholders' interests towards common adaptational goals.

[6] http://www.adaptationlearning.net

3. Adaptation Delivery

Rarely does climate change directly affects countries or communities. Instead, as shown in Figure 3, it is one of a number of shocks that are mediated by – and exacerbate – existing vulnerabilities. Adaptational priorities vary depending on particular national vulnerabilities, and ICTs' role in delivery of those priorities generally relates to specific vulnerability sectors or issues. These are discussed in greater detail in the next section and in Figure 4.

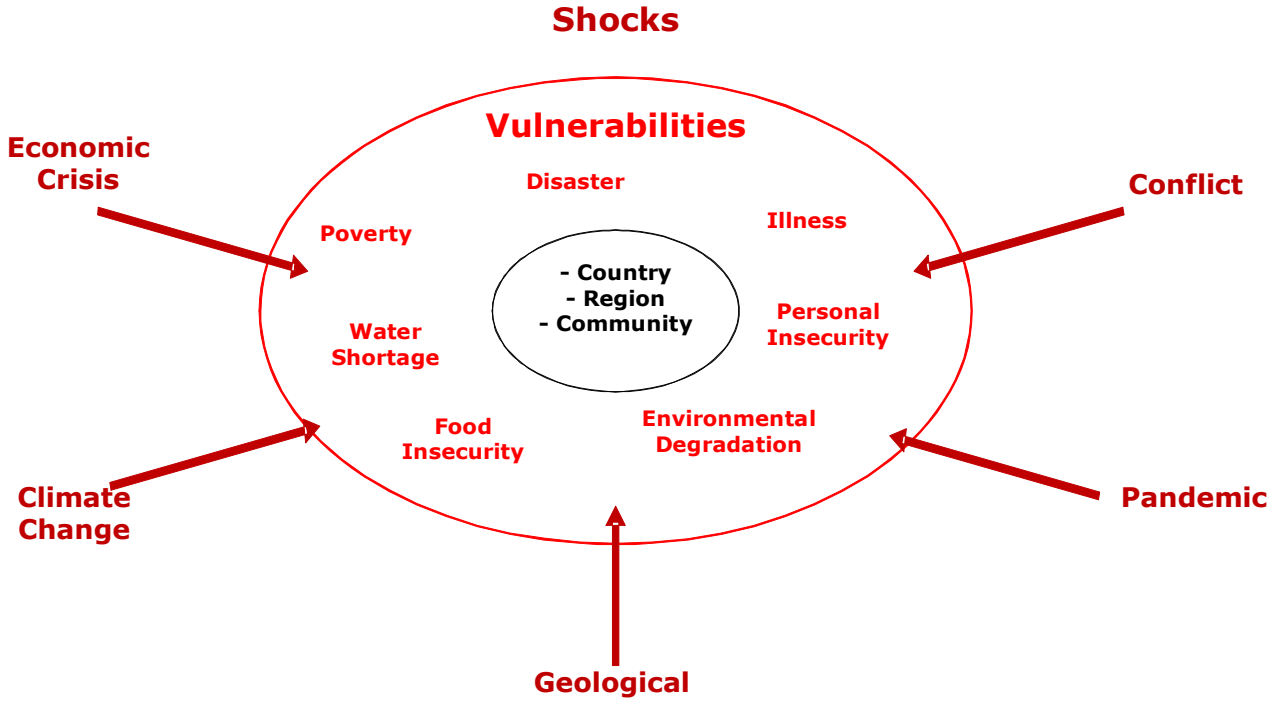

Figure 3. Relation Between Climate Change, Other Shocks and Vulnerabilities

4. Feedback & Learning

The development of an adaptation strategy/plan is not an end in itself, but the start of a process of continuous learning. The generation of feedback, the creation of new knowledge and the dissemination of existing and emerging experiences are key components of successful adaptation strategies. At present, adaptation strategies have too often been implemented according to a linear rather than a cyclical model. ICTs can help bridge the missing link by providing feedback on the impact of adaptive actions through geographical and sectoral information systems.

ICT tools such as Web 2.0 and online media can play a key role documenting traditional practices, and convening emerging sources of expertise in joint efforts towards the creation of climate adaptation tools. The use of ICTs for environmental observation, monitoring and networking enables users to assimilate, translate, use and share information in novel ways, enhancing the learning cycle [7]. e-Governance systems can provide transparency and accountability of the resources being invested in adaptation. And through online communities of practice, ICTs can provide the means for learning and continuous improvement in strategic planning and implementation. Thus, emerging digital knowledge and learning can help to strengthen adaptation plans by providing iterative flexibility, facilitating continuous adjustment of adaptational actions.

5. Institutional Capacity-Building

Effective formulation and implementation of plans requires institutions that can enable the flow of assets, skills and values necessary for undertaking adaptive actions, including the provision of access and connectivity in marginalised areas. The four areas for ICT application described thus

[7] Ospina, A. V. & Heeks, R. (2010) *Unveiling the Links between ICTs & Climate Change in Developing Countries: A Scoping Study*. Centre for Development Informatics, University of Manchester http://www.niccd.org/ScopingStudy.pdf

far strengthen the institutions involved in adaptation strategies, and can foster a broader capacity-building process aimed at providing a digital institutional infrastructure that can readily develop, share and utilise a whole range of digital data.

Examples that illustrate how ICTs contribute to institutional strengthening include the facilitation of multi-level networking and coordination of intra/inter-institutional actions, as well as efficiency and transparency in the assignation of adaptation resources. The use of climate models and GIS applications for visualisation, mapping and modelling of climatic risks and vulnerabilities can contribute to informed decisions in planning and policy design, as well as to build synergies between adaptation and other development and environmental strategies implemented in the country. Information systems have a key role to play in the effectiveness of policy measures such as tax administration or incentive structures designed to encourage environmental practice, or mitigate climatic impacts among vulnerable populations[8]. At the same time, the use of ICTs for e-learning can support capacity building and skills-update programmes on climate change issues, particularly among institutional actors/employees located in remote areas.

The availability, access to and dissemination of relevant climatic information and knowledge constitute the basis upon which subsequent stages of strategising (i.e. planning, design, implementation, monitoring and evaluation) can be tailored to the specific adaptive needs and priorities of developing contexts. At the same time, a flux of relevant information and knowledge among all stakeholders throughout the adaptation process is pivotal to ensure continuous learning, feedback and flexibility of plans in face of future climatic uncertainty.

(b) Sectoral Adaptation

The role of ICTs in delivery of adaptation actions can also be analysed from a sectoral perspective, by linking their potential to the specific needs and priorities of key sectors affected by climate change, as overviewed in Figure 3 and as specifically detailed in Figure 4.

VULNERABLE SECTORS	Examples of Adaptation Measures	Sample Areas of ICT Potential
POVERTY	• Increasing income	• ICTs can be used to get money; most obviously through e-enabled or m-enabled remittance systems. • ICTs can be used to better manage money; for example through m-finance and m-banking applications, and also (overlapping with the category above) through ICT-enabled microfinance. • ICTs can be used to make money through the formation of ICT-enabled microenterprise, including ICT-based retailing (e.g. sales of mobiles, accessories and calls), creation of digital content (e.g. music, photographs), digital services (e.g. cyberkiosks, telecentres), and digital production (e.g. data entry, digitisation).
WATER RESOURCES	• Better management and use of water supply • Development of flood controls and drought monitoring • Water policy reform	• ICT applications such as GIS and remote monitoring can support the improvement of water resource management techniques, and the monitoring of water resources. Software and ICT-based models can contribute to water security by helping to manage and document scarce water resources (e.g. melting glaciers, salinisation and pollution of fresh water sources), and water distribution. • ICTs such as mobile phones can be used in participatory monitoring systems, enabling users to provide near-real time data during the occurrence of floods or droughts. • ICT tools can also help to monitor water supply levels and the degradation of water quality due to increased temperatures and pollutants, providing updated data that can inform policy processes - including those related to pricing and irrigation.

[8] Ibid.

VULNERABLE SECTORS	Examples of Adaptation Measures	Sample Areas of ICT Potential
AGRICULTURE & FOOD SECURITY	• Development of tolerant/resistant crops • Diversifications of crops • Supply chain strengthening • Policy measures	• ICTs can be used to access information and knowledge to strengthen local agriculture and livestock production systems. Applications such as mobile phones and community radios can be used to disseminate information in appropriate, simple formats on new seeds and crops variety, livestock breeds, irrigation applications, reminders about planting dates, pest and disease control, livestock vaccinations, alternative fertilizers, among others. • The use of ICTs such as mobile phones can also help to improve market access (through information on prices and consumer trends) and support capacity building opportunities for local farmers via better links to suppliers. • GIS and related applications provide essential data for monitoring short- and long-terms agricultural trends that inform policy formulation and implementation.
HUMAN HEALTH & HABITAT	• New or improved disease/vector surveillance and monitoring. • Changes in urban settlements and housing design	• ICTs such as community radio can help to raise public awareness on methods to prevent or mitigate the spread of some vector-borne (i.e. malaria and dengue) and water-borne diseases. Web and mobile applications can draw data from, and provide guidance to, healthcare professionals. • ICT applications can be used in urban planning (i.e. GIS), and in monitoring and provision of relevant environmental information to support decision-making processes contributing to the adaptation of human habitats and infrastructure. • ICTs are central to monitoring the displacement and settlement of populations due to sea-level rise, drought, desertification, etc.
TERRESTRIAL ECOSYSTEMS	• Creation of parks/reserves and protected areas • Better assessment of the vulnerability of ecosystems • Monitoring of species/biodiversity	• GIS and remote sensing applications can provide valuable information to manage and monitor parks/reserves and protected areas, contributing to the conservation of ecosystems. • ICT applications are used in climate models and predictions to inform decision-making processes and raise awareness on the impacts of climate change in local and national biodiversity. ICTs can provide illustrations, satellite images and photographs related to human and climate change impacts on the environment.
COASTAL ZONES & MARINE ECOSYSTEMS	• Better coastal planning and zoning • Development of legislation for coastal protection • Research and monitoring of coastal ecosystems	• ICTs can be used for mapping, visualisation and generation of real-time data to monitor short and long-term trends affecting coastal ecosystems. GIS and remote sensing applications can support coastal planning and zoning, by providing updated and locally relevant information for decision makers. • Mobile technologies (e.g. smart phones and PDAs) are used to facilitate the collection, retrieval and analysis of data, as well as its dissemination of information in near-real time in order to mobilise diverse stakeholders towards local conservation actions.
DISASTER MANAGEMENT	• Early warning • Disaster response • Reconstruction	• ICTs such as mobile phones and local radio are central to broadcast of disaster early warnings. • ICTs enable rapid data gathering during emergency response, prioritised decision-making, and facilitate logistics. • Decision-support and geoinformatic systems underpin the planning of post-disaster reconstruction; ICTs can also help to mobilise and monitor reconstruction efforts.

Figure 4. ICTs' Contribution to Sectoral Adaptation Measures & areas of ICT potential (adapted from UNFCCC 2007)

Moving Forward: Principles and Practice

ICTs can play a foundational role in enabling innovative climate change adaptation strategies at both the national and the sectoral level. The following good practice principles and action steps highlight how this potential can be realised:

(a) Guiding Principles for ICTs and Climate Change Adaptation

- ***Integrate Don't Isolate***

  Climate change is one of many shocks that will ripple through to developing countries via multiple vulnerabilities. Thus nations, regions and communities need to adapt to all of the challenges of the 21st century, not just to climate change. ICTs should not be understood narrowly in terms of climate change adaptation, but broadly in terms of adaptation overall. Instead of building unique, stand-alone ICT applications for climate change adaptation, it is necessary to adopt an integrated approach. Priorities are to integrate climate change issues into current and future ICT initiatives; and simultaneously to integrate both climate change and ICTs into current and future development initiatives.

- ***Empower Emergent, Grassroots Adaptation***

  Pre-planned NAPAs and other high-level strategies have an important role to play. But local, flexible, emergent adaptation will also be required because of the unpredictability and disruptiveness of climate change. ICTs must not just support NAPAs, but must also help to create and extend local resilience and adaptive capacity so that the latter type of adaptation can also flourish.

- ***Bottom-up … and Top-Down***

  Local and national actions should not be seen in isolation from one another. Building adaptation capacity and fostering participation at the grassroots level with the help of ICT tools needs to be combined and complemented with top-down political buy-in. That high-level political support includes action on general ICT policy, extending connectivity to all areas but also ensuring the full range of 'information chain' resources that enable data to be converted into developmental action[9]. In addition, adaptation strategies need to be informed not only by emerging scientific knowledge that is relevant to the local context, but also by traditional knowledge, acknowledging the empirical and indigenous resources that exist locally. ICTs can be used to help bring these two knowledges together; integrating them for more effective adaptation.

- ***Embrace the Current Informatics Ecosystem***

  Thinking about ICTs' role within adaptation strategies is not about specific applications, but about informatics – the ecosystem of data, information, knowledge, technology, and social processes that can support adaptation. To focus on informatics, adaptational strategies must encompass the informational and social context within which the technology operates. An ecosystem approach will also recognise the 'stovepiping' that separates technologies of reach (mobiles, radio) from technologies of power (Internet, computers). It will seek applications that combine reach and power by working with an integrated 'info-system' of mobiles, telecentres, mass media, etc[10].

[9] Heeks, R. & Kanashiro, L.L. (2009) *Remoteness, Exclusion and Telecentres in Mountain Regions: Analysing ICT-Based "Information Chains" in Pazos, Peru*, IDPM Development Informatics Working Paper no.38, University of Manchester, UK http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/

[10] Prasad and Heeks (2011), op.cit.

❖ ***Recognise ICTs' Productive and Transformative Roles***

Current adaptation efforts have a narrow and outdated worldview that sees ICTs as data-handling tools. This perspective does not reflect the rapidly evolving user roles and capabilities that digital technologies allow for. Well beyond their informational capacity, ICTs have demonstrated productive and transformation potential through their support to social and market transactions, the productive creation of content and livelihoods, and the "Development 2.0" model that is transforming existing structures and processes[11]. In particular, both applications and implementations are lagging in ICT-enabled income generation, despite money being the single most important component of adaptive capacity. There has to be a new mindset. And further collaboration is needed between the private sector and social enterprise to innovate; to roll out new hardware, software, and systems that can shift outdated ICT paradigms in regards to climate change; and to fulfil ICTs' adaptational potential.

(b) Action Steps

These principles can be enacted through concrete, action-oriented measures:

- ***Identify the role of ICTs*** in both emergent and planned adaptation in the country, including the main information needs and gaps.
- ***Identify priority areas and windows of opportunity*** where the role of ICTs could be strengthened or integrated in support of adaptation.
- ***Form partnerships and coordinate actions*** with climate change adaptation stakeholders at different scales (micro, meso and macro), and from different sectors.
- ***Engage key high-level players*** working at the Ministerial level in climate change adaptation, disaster management, development planning and ICTs.
- ***Raise awareness*** and provide discussion forums (both face-to-face and online) on the potential of ICTs in adaptation, at both national and grassroots levels.
- ***Design, implement and document*** ICT pilot demonstration projects as part of ongoing adaptation initiatives or strategies, in order to engage multi-sectoral stakeholders and draw lessons for larger scale implementation.

The potential of ICTs within processes of climate change adaptation is multi-dimensional and transversal, and it can also be transformative. Efforts to integrate these tools within innovative adaptation strategies should look beyond the provision of information, and include their role in the development of local capacities, the empowerment of local actors, and the strengthening of institutions through enhanced collaboration, networking, self-organisation and informed decision-making, ultimately building the resilience of vulnerable contexts.

The **Climate Change, Innovation and ICTs** Project is an initiative led by the Centre for Development Informatics (CDI) of the University of Manchester, UK, with funding support from Canada's International Development Research Centre (IDRC). Further information about the project and related resources can be found at: http://www.niccd.org

[11] Heeks, R. (2010) *Development 2.0: Transformative ICT-Enabled Development Models and Impacts*, Development Informatics Short Paper no.11, Centre for Development Informatics, University of Manchester http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/#sp

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