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DISRUPTORS AND ENABLERS OF RESEARCH FOR DEVELOPMENT (R4D)

Drivers, trends and weak signals on the horizon

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Overview

We are living in an increasingly volatile, uncertain, complex and ambiguous (VUCA) world. To be future-fit, research and science systems need to be resilient and responsive to short-term and long-term changes in the face of global shifts in economies, societies, politics and geo-politics, the natural environment, technology and understandings of governance.

This brief outlines key *drivers* (understood as long-term shifts that affect the entire world, such as urbanization, digitalisation, demographic shifts or climate change), *trends* (directions of change over time, evidenced by a supply of data points) *signals* (a single piece of evidence supporting a trend or indicating a potential change in a trend) and *themes* a (mix of related trends across an area of strategic importance) that will likely influence the strategies of researcher communities and those who support them over the next 10 to 20 years. They are drawn from a horizon scan undertaken as part of the IDRC project Disruptors and enablers of research for development: exploring futures.

The horizon scanning process drew on a database of over 200 scanning 'hits' categorised systematically to help with analysis. Horizon scanning is alert to signals of drivers and trends that could include shocks and disruptors, changing contexts, new ways of doing things and other factors that could enable desirable futures. The database 'hits' were categorised using the STEEP-V taxonomy as disruptors or enablers and as weak signals, drivers or trends. They were then analysed inductively to develop the themes and associated subthemes that form the rest of this report. While the themes are analysed separately there is a good deal of interdependence between them.

Foresight exercises are designed to open up new ideas about desirable futures and new ways of getting to them so there are no recommendations at the end of the report. The analysis is presented in two sections: first, the implications for R4D ecosystems, research and researchers and second, the implications for R4D funders. The summary section highlights issues R4D funders will need to consider as they debate with their partners and among themselves how the wider research community could respond to our significant global challenges.

1 Research ecosystems, research and researchers in a VUCA world

1.1 How universities deliver training and research skills

Who can access education and learn will change as we evolve our ability to use digital technologies to deliver education.

a) **Tech centred learning and research is changing the delivery of education**: The rise of AI in education could change how education could be delivered through personalised learning, which in turn could change what we understand by 'a university'. This does not need to be limited to education delivered lecture-style: the advent of 5G, robotic technology and the metaverse are already allowing doctors to deliver surgery remotely. The same could be possible for some elements of research and education that currently rely on students' physical presence in laboratories, though there will be significant costs associated with setting up these remote technologies and there can also be significant costs if overhyped edtech fails.

b) **Acquiring accreditation and skills may become more flexible**: The process of acquiring the credentials of 'a university education' need not be limited to a single university. MOOCs (Massive Open Online Courses) are already a well-used way of delivering knowledge and providing accreditations. The rise of self-managed digital identities, AI-enabled SPOCs (Small Personalised Online Courses), personal educational administration, digital nomadism and systems of stackable university credits could allow far greater freedom of choice in how learners manage higher education, though increased flexibility and personalisation could lead to researchers demanding more choice in the mix of research skills they want to acquire, how they want to acquire them and how they want those skills to be accredited

c) **Who can access education and learning will change**: Anyone with a phone could access a personalised tutor meaning that a virtual university education could have a much greater reach, for example into rural areas where solar mini-grids and low-earth orbit satellites could enhance electrification and internet access. However internet access still remains subject to political oversight which could affect student learners if authoritarian governments feel threatened by increasingly engaged and skilled youth.

d) **Access to meaningful, appropriate education will increase for some but not all**: An over-reliance on tech to deliver education could marginalise local or indigenous knowledge by centralising the delivery of knowledge to a small group of well-resourced institutions and people, likely located in urban centres. And tech comes with privacy concerns around mis/dis/mal-information, AI-enabled spyware and client-side scanning of encrypted platforms.

These changes would have significant equity implications, reinforcing divides between apex universities and those in secondary cities or remote areas with fewer resources to make the switch, and divides between public and private educational establishments.

How universities deliver training and research skills: implications for R4D funders

First, the changing nature of 'a university education' would have implications for how someone qualifies as 'a researcher'. R4D funders would need assurance that digitally nomadic researchers have acquired a good, accredited and recognized education from a personalized pick'n'mix box of stackable credits. Research expertise is currently built via a hierarchical career progression but in a VUCA world this could cement unhelpful incentives: it is unclear what types of research career this could encourage or what benefits a digital, nomadic researcher would gain and lose.

Second, the changes could affect who could become, or could be defined as 'a researcher'. Greater access to training could create more options for people to pursue research as a career, particularly with an increased emphasis on use-focused research. However, if countries are unable to open effective and equitable gateways for accessing these skills they risk further embedding educational inequalities.

Third, the nature of 'a research team' could change: we have seen this in the social sciences as the pandemic restructured how researchers collaborated remotely. But digital technologies that enable remote participation by emulating physical interactions could alter how research is conducted in the hard sciences, which currently rely on physical laboratories – with losses as well as gains. Digital technologies could also stimulate the development of new types of research actors capable of undertaking high-quality research.

It will be important to understand what this means for how a research career could be structured and delivered without embedding structural inequities, whether more open accreditation systems that build stackable credits would encourage or discourage researcher migration (see 1.2) and what this might imply for how researchers want to work and to collaborate in future.

1.2 Migration patterns and researcher mobility

Recognising and understanding migration patterns will be key to understanding where R4D funding is best directed, how to ensure that researchers take their accreditations with them, and how to develop effective research collaborations.

a) **LMIC populations (not just in Africa) will increasingly be young, urban, digitally savvy, connected but climate-vulnerable**. This will have implications for their job prospects, the types of education they seek and the pull of migration. Known push factors (educational quality, poor working conditions, job insecurity, the climate crisis and political instability) will continue to influence migration rates and patterns.
b) **Most migration is likely to remain intra-regional rather than inter-regional**, though this is not true of academic scientists who migrate internationally to further their research careers. Little is known about where industry scientists migrate from and to, but as organisations fostering regional economic integration begin to stimulate national and regional growth this will change the attractiveness of job opportunities in industry research, influencing who chooses to migrate, for what purposes, and where they choose to migrate to.
c) **The rise of BRICS as sources of bilateral aid to LMICs could change incentives about the location of higher education study** (either in person or remotely), reducing reliance on North American and European universities.
d) **MOOCs, SPOCs and stackable credits (see 1.1) could reduce incentives to migrate for higher education**. Systems for accrediting academic staff would need to be made similarly mobile to ensure that researchers forced to migrate would not be disadvantaged.
e) **Mobility is a strategy for researchers to get around limitations in national research infrastructures**, but the concept of 'a national research infrastructure' could change if inter-regional groups of researchers band together to anticipate their joint research needs and share approaches to research capacity building. This could be particularly important where large financial flows influence the amount, direction and nature of national and regional needs for research (eg the Green Climate Fund).

Migration patterns and researcher mobility: implications for R4D funders

Technology will change the nature and reach of higher education institutions and our ability to personalise academic offerings. This will broaden the options facing young people who want a career in research and will affect how individual researchers gain skills and build collaborations, particularly in fragile and conflict-affected regions. However, researchers who are forced to migrate to different countries, sub-regions or regions may not have their academic accreditation recognised, losing their ability to teach or do research. A more personalised, tech-enabled approach to acquiring skills would need to be supported by a system of accreditation that can move internationally with the researcher.

R4D funders can play a useful role in helping governments and regional organisations plan to meet future demands on their research systems by understanding national and regional development priorities and what they imply for the types of research skills that will be needed. New modes of international research programming and funding could be developed to help embed a transformative agenda, encouraging new types of actors to engage in international research efforts and to reduce their barriers to entry in research ecosystems.

1.3 How AI is redefining research quality and research possibilities

Artificial intelligence shows considerable promise as a research tool though its potential for use by bad actors means that it needs to be approached with caution. In addition, it is only as good as (and as biased as) its training datasets which are often of very poor quality in low- and middle-income countries.

- **The quality of solutions generated by AI relies on the quality of its underlying data.** AI relies on benchmark (training) data to develop its algorithms and this is currently heavily skewed towards data from the anglophone global North. This means that if AI is used to address topics of importance to LMICs, its outputs are at best irrelevant and at worst downright mischievous (not just wrong, but badly wrong). But even if AI is trained on local datasets, the paucity of the underlying data means that the algorithms are unlikely to deliver accurate assessments. This means AI's validity in local research ecosystems is likely to be patchy, with implications for how effectively it can be used to support collaborative, transformative research.
- **However, AI could help improve interoperability between datasets and applications**: datasets gathered against different parameters could be merged, increasing their accuracy and utility. AI models are being developed which could learn to improve the quality of datasets used in research and policymaking.
- **With high quality training data and careful analysis and monitoring of the algorithms, AI could merge different types of evidence** such as impact science and citizen science into something fruitful and locally meaningful by incorporating indigenous knowledge.
- **Funding for AI startups has been volatile but much AI research in the global north is funded by big tech** which draws AI researchers away from academia. Global philanthropists who fund data science and AI are often highly solutions-oriented and less interested in solving fundamental under-the-hood issues of (eg) data quality.
- **There is increasing momentum behind the open-source movement which is developing smaller, more agile models of AI** that use natural experiments to refine training data, making them more readily tailored to specific LMIC contexts. Open source allows developers to custom build high-powered computational environments and support the development of other scientific hardware which could help universities in LMICs overcome lock-ins to proprietary software and legacy systems. However this is not a total solution, as legacy hardware is unlikely to have the capacity or security to run new-build OS software programmes.

How AI is redefining research quality and research possibilities: implications for R4D funders

AI is the epitome of a VUCA issue, with extreme uncertainty around the impacts of AI and AGI models given how close we are to developing them. But using them effectively in low- and middle-income countries rests on the quality of their training data which in most instances is very poor. The emergence of new (diffusion) models of AI could lead to a step change in the quality of training data which would lead to a similar step change in the utility of AI in LMICs. But this will need a significant investment—in the near future—from governments, the open source movement, the private sector and research funders. R4D funders could lead on these discussions about how to build local capacity to strengthen the quality of AI's training data:

- Making the case for more investment in R4D, particularly around the development of training datasets from LMICs to avoid the northern bias that is rapidly emerging in AI and which can generate solutions with very limited applicability (or wrong solutions). This would be linked to a larger global conversation on data quality for data science led by the UN Statistics Division and Paris21.org.
- Ensuring that LMIC researchers are increasingly well represented in the open-source movement and have access to the sustainable computing power they need to contribute effectively to model development.
- Engage with the private sector (Google, Microsoft, Meta) alongside engagement with the open source community to boost globally equitable approaches to research into AI and its applications.

R4D funders could also engage with the OS and Web 3.0 movements to understand how issues of trust in the evidence, verifiability of research results and intellectual property rights in research could play out in future. And LMIC research institutes will increasingly need help to overcome the problems they face with legacy hardware and software to ensure they are able to participate equitably in those discussions.

1.4 Research and responsible and transparent digital governance

Our understanding of how to govern our digital societies is not keeping pace with the development of digital technologies, particularly around AI and Artificial General Intelligence (AGI).

Digital governance:

a) **Recent developments in AI have alarmed key actors** who have called for a moratorium on further developing generative AI and on the search for Artificial General Intelligence (AGI) until responsible approaches to its governance have been developed and implemented. China took an early lead in developing regulations around generative AI, and the EU and USA are racing to catch up with legal and civil frameworks and safety legislation but the pace of governance changes is far slower than the pace at which AI developers are working and releasing new models.

b) **Concerns are about a major misuse of AI with real-world consequences**: In the meantime there is a possibility that a major AI misuse event – either through series of correlated failures in AI-based systems or weaponised by a malicious actor or an authoritarian government – could have serious effects in the wild with two possible effects:
   - **Governments would sit up and regulate generative AI closely**. But it is unclear whether this will be done on a country-by-country basis (China is banning AI-generated media without watermarks) or on a regional basis. Although many LMICs have been forced to follow the EU's stringent GDPR regulations, the responses from China and some LMICs to the war in Ukraine has shown that LMICs do not anymore

see the US and EU as leaders in designing regulation that has international implications.
    - **There could be a global loss of trust in online information and social media**, leading to a chaotic breakup of the current social media landscape and its re-establishment on a regional or country basis, behind national firewalls.

Digital sovereignty:

c) **The idea of national sovereignty over the online world is appealing to autocratic governments, being closely linked to a national sense of identity.** As we move towards a multipolar geopolitics with the rise of China and its courting of LMIC governments, countries will increasingly see digital sovereignty as key to self-determination in the digital arena. This will have implications for how digital technologies (including research tech) can be used and for what purposes. Together with concerns about AI this could lead to the development of national firewalls with implications for international research collaborations.

d) **The next phase of the Web (Web 3.0) will be more decentralised, secure and user-friendly** than the current phase (Web 2.0). This could help displace social media companies that rely on harvesting personal data and change how people think about work and learning. It could also have implications for how research topics are devised, funded, delivered and communicated.

e) **Some competition authorities in the global North are increasingly scrutinising big tech** (notably including AI and the cloud) to try to ensure that they do not become institutional monopolies of the infrastructure on which future tech developments could take place.

Research and responsible and transparent digital governance: implications for R4D funders

In the very near future there will be a surge in global discussions about digital governance related to the governance of AI and AGI. There are no globally agreed guidelines on how researchers should study, release and report safety concerns about the effects of AI in the wild: R4D funders are well placed to contribute to those discussions, incorporating views from LMICs.

In the long term R4D funders need to consider the nexus of digital governance, digital sovereignty and global geopolitics. LMICs are increasingly refusing to align with the West against the China/Russia axis which will have implications for how they develop their own understandings of digital sovereignty and digital governance, and what guardrails they implement as a result. These could be around how partially they allow Web 3.0 to be implemented, how national firewalls are designed and how AI is regulated. All of these have implications for how research is funded, managed, delivered and communicated.

1.5 What the polycrisis means for research

The compounding effects of the polycrisis need to be reflected in what issues R4D funders support, how they provide the support, how research findings are communicated and how research and research programmes are evaluated.

a) **The defining characteristic of the polycrisis is that individual risks will compound to create tipping points**, which merge with persistent crises to create vicious circles and potentially catastrophic outcomes.

b) **Understanding the potential second- and third-order effects of these compounding issues will require foresight and transdisciplinary approaches** to devising the research question, conducting the research and communicating its findings. The compounding effects will vary between locations, meaning that research will need to be increasingly tailored to local requirements. In some cases AI could help localise the implications of globally relevant research findings but only if the issue of poor training data in LMICs can be overcome.

c) **The pandemic highlighted that social recessions are as damaging as economic ones**. While economic growth remains important, GDP as an indicator of economic growth will become part of a broader global aim to improve human and environmental wellbeing.

d) **In the context of intersecting crises, using wellbeing as a primary goal would mean defining it locally**. This would encourage a focus on use-inspired research (basic and applied) with implications for how national curricula are developed, moving towards methods of teaching, research and collaboration that encourage systems change.

e) **The WEF 2030 risks report counts 'erosion of social cohesion and societal polarization' as a high risk for global development**. This could be further enhanced by the effects of mis/dis/malinformation, particularly where it is AI-enabled and weaponised by bad actors.

What the polycrisis means for research: implications for R4D funders

Given the time lags inherent in research, funders will need to cement foresight and risk assessments into research program design. Two linked issues stand out. First, while fundamental research is still needed it has a long time-lag. At a programme level a more systemic approach to interrogating how issues compound with one another suggests a transdisciplinary, use-inspired and risk-aware approach to devising research questions and communicating the findings. A use-inspired approach would emphasise defining the research questions with local communities, analysing results in collaboration with user groups, and incorporating use-inspired requirements into project and programme evaluations (such as recognising second-order and third-order effects of the research). A more systemic approach would build programmes organically in response to insights from communities in the global South, foresight exercises and risk assessments. This means going much further than simply 'incorporating Southern perspectives' on programme design and governance, which could lead to tensions within the R4D funding community over the extent to which they control the programs they fund and how they report to their respective governments.

Second, the decline of disruptive science suggests that publicly funded research is too focused on incrementally validating what is already known rather than on supporting risky, speculative work that leads to discontinuous discoveries. The danger is that the only big bets on research are placed by the private sector which is subsequently able to capture and monetise the gains leading to inequitable solutions.

In the face of increasingly sophisticated tools for spreading mis/dis/malinformation and widespread distrust of authority, R4D funders will need to rethink their own roles as communicators. A use-inspired approach to funding research would embed the research process more deeply within communities, with the risks that researchers (and their funders) become seen as political actors. R4D funders would need to consider their own responsibilities for countering mis/dis/malinformation around the research they have supported.

1.6 Decolonisation and research

International research funders can help lead the decolonisation movement by paying attention to how research is conceptualised, administered and governed, building a different understanding of 'international development'.

a) **The decolonisation of aid has important implications for the decolonisation of research**. The decolonisation agenda is likely to focus more squarely on a justice-centred approach to reparations with individual countries taking the lead in defining the types and amounts of 'aid' they should receive and how they put it to use. This discourse will influence how internationally funded research programmes are designed, managed and evaluated.
b) **The 'R4D' terminology is becoming rapidly outdated**. A group of South African university students who were informally quizzed for this project wholeheartedly rejected the 'for development' phrasing. Groups of national research councils are increasingly working together at regional levels to share resources for all types of research, building their own research ecosystems with their own funding sources. A concerted effort to ensure that LIC/MIC researchers are well represented in the open-source movement could help support cross-border research collaboration.
c) **The 'impact of aid' as a unifying concept will become less meaningful** as groups of countries pursue separate and equitable bilateral and regional research partnerships, supported by local evaluation communities who will develop more contextually appropriate methods for monitoring, evaluation and learning. Local demands on international research funders are likely to emphasise support for national and regional research funding councils in LMICs to anticipate and make good use of massive global funding flows for climate and sustainability, to address local and regional priorities.

Decolonisation and research: implications for R4D funders

R4D funders can be at the forefront of implementing the decolonisation agenda, understanding what equitable research partnerships would look like in a decolonised world and devising and implementing new research prioritisation and management processes, funding modalities, quality assessment tools and MEL approaches. Building a different 'engine room' for research will be essential to ensure that international R4D funders help lead, rather than drag, a decolonising approach to global change.

Capacity strengthening in LICs and MICs will remain an important part of R4D collaborations, particularly around the issue of data and research infrastructure. This will have implications for some of the research infrastructure in donor countries which has developed around particular funding models and modalities.

2 Funding research in a VUCA world

2.1 The role of research funders

A key challenge for all governments is to build centres of education able to turn out a workforce with the skills needed to address each country's development priorities. This means supporting local and regional research institutions to recognise the need for change and design a new research infrastructure.

a) **Given the urgent challenge of finding jobs for young people, governments are likely to become more interventionist**, designing economic transformation programmes and directing resources towards specific sectors, industries or social support systems which offer the most potential for high growth, high youth employment and environmental benefits. An emphasis on regional approaches to fostering growth could translate into regional research hubs which respond to regional priorities. This could help reduce the push factors that contribute to researcher migration.

b) **Where shocks disrupt already fragile political systems, international actors such as research funders will have to navigate increasingly politicised environments** with the risk that they are accused of sympathising with those dubbed as anti-government actors. New actors that challenge the nature of traditional think tanks could emerge as part of a wider set of changes in the research infrastructure.

c) **Without significant economic growth, public sector resources will become scarcer, including for research**. Research establishments may become politicised or chronically dysfunctional, widening inequalities in education provision. Digital technologies could offer significant benefits to individual researchers, but the danger is that early adopters leave the less well-resourced educators behind in the race for funds and that international research actors enhance these inequalities.

d) **There is an underlying trend towards the commercialisation of research findings and away from the social sciences**. Research tends to be rewarded for producing tangible, outward-facing, commercially relevant outputs rather than the fundamental, global, long-term, transdisciplinary work which helps us think broadly about global development issues. This has tended to privilege the natural sciences over the social sciences and to reduce the amount of attention paid to power relations: not just power relations over science and technology but power over productive assets that will be key to the sustainability transformation.

The role of research funders: implications for R4D funders

R4D funders can play an important role in discussions about how to translate national development priorities into a responsive, resilient and vibrant research infrastructure. This will mean engaging in high-level debates that determine long-term priorities, working with other global funding streams to help anticipate what the research infrastructure will be needed to meet those priorities and how to achieve it.

Young people are becoming increasingly aware of the potentials of digital technology: they are likely to be less accepting of the traditional research hierarchy and disciplinary tramlines, demanding a more personalised approach to acquiring expertise and experience. This will change how they view a research career and international research collaborations.

New international research actors may emerge. Using foresight to anticipate their emergence, mapping them and understanding the barriers to their entry into local research systems will be important if international research is to be inclusive. It would also help develop more inclusive ideas about R4D and other complementary funding pathways, find new modes of programming that help embed a transformative agenda and understand what characteristics of these new approaches help foster resilience and responsiveness in national and regional research systems.

2.2 Funding modalities

Anticipating changes in how research skills are acquired, how expertise is built and how international research collaborations are managed leads to a question of how different funding modalities help deliver transformative R4D and science systems that are equitable, open, capable and connected.

a) **R4D funders will need to monitor how the structure of aid and development finance is changing** with the rise of private sector finance, increasing amounts of aid allocated for emergency responses and the rise of BRICS as sources of bilateral aid. All these actors will be engaging with governments, and all could contribute insights into how to develop a resilient and responsive research infrastructure that can help international research deliver transformative change. But pressures to localise aid and the decolonisation debate may require research funders to accept a smaller role in debates about international research than they think they warrant.

b) **There are likely to be large-scale changes in what we understand by 'a university education'** as digital technologies and particular AI changes how research skills are delivered, acquired, and accredited. Already under-resourced research establishments will struggle to respond which risks cementing inequalities in national research infrastructures. There may be opportunities to consider whether deliberately supporting open-source approaches could help research establishments struggling with legacy digital hardware and systems. This could be expensive in the short term but with certain long-term payoffs. But for some issues, developing an appropriate public research infrastructure could be so complex and expensive it would require international collaboration to construct and run it.

c) **R4D funding streams will need to strike a careful balance** between consolidating expertise around national and regional priorities for development and building responsiveness into the research system so it can react quickly to emerging issues. Monitoring the performance of international research funding streams will need to be done with an eye to new indicators of development progress (see 1.5).

d) **Dependence on donor funding can condition particular organisational models which may not give research organisations the flexibility a VUCA world will require**. Funding constraints tend to lead to shorter-term, safe rather than innovative bets and to reduce funding to disruptive, discontinuous, potentially game-changing ideas. The emergence of new types of research actor could require different types of funding, building on the ideas of income share agreements or lotteries.

Funding modalities: implications for R4D funders

To help deliver transformative change, global research systems need to be able to anticipate and respond to future needs for research in a fast-changing, VUCA world. Funding modalities for R4D need to help drive these changes, helping LMICs respond to their local and regional needs within a global context. Decolonisation implies a new set of relationships with research institutions, governments and other funders which could open the way to designing new types of funding stream. This will need to consider how research skills will be provided and accredited in future, to help countries and regions in the global South develop a research infrastructure that is resilient in the face of the polycrisis and able to respond quickly to its compounding effects.

3 Summary: redefining the international R4D agenda around issues that matter

Foresight offers the opportunity to consider radically different futures and radically different ways of getting to them. Earlier work in this project outlined the desired characteristics of future research systems as being *resilient* to the effects of the polycrisis, *responsive* to future needs and with abilities to deliver *transformative* change. Horizon scanning helps identify disruptors and enablers on the multiple possible paths to desirable futures. Even from this brief analysis of weak signals it is apparent that because of the scale and pace of the challenges, research that is poorly specified and commissioned, poorly conducted, and poorly delivered will effectively act as a disruptor across all those paths. However, the analysis also identifies opportunities for R4D funders to enable a global research system that can anticipate those global challenges and meet them head-on to deliver transformative change. Enabling such systems will mean making them, open, capable, and connected, as in Figure 1.

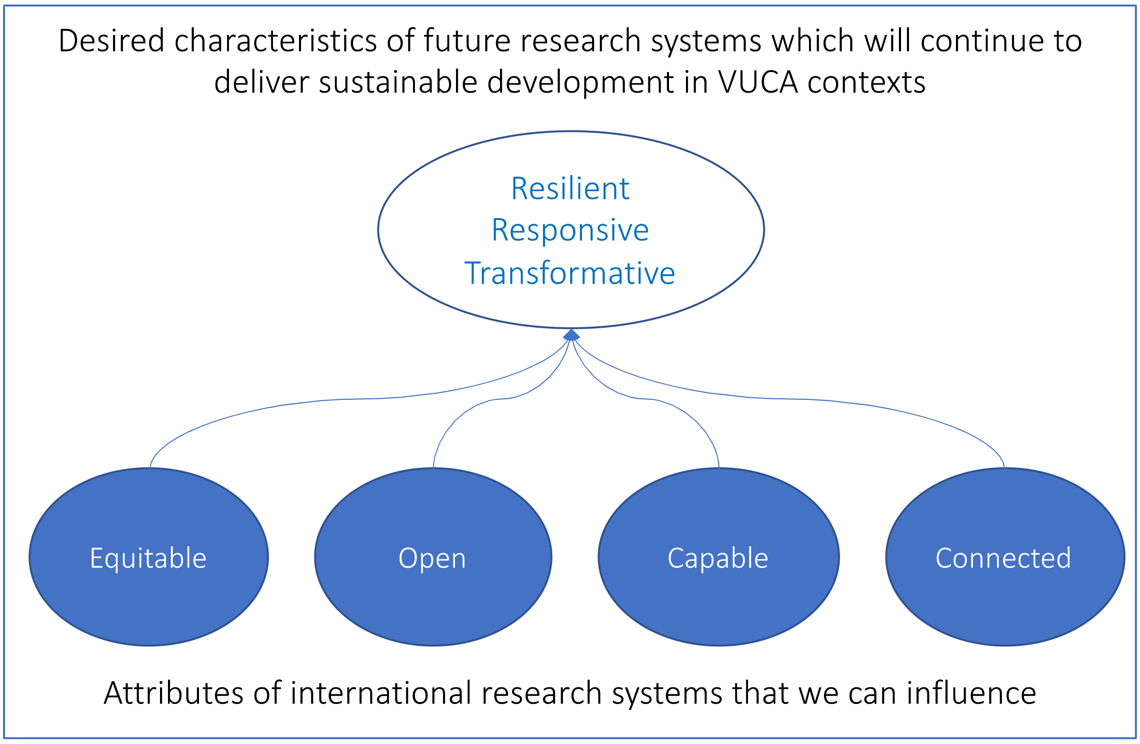

Fig 1: the characteristics and attributes of effective research systems in a VUCA world (source: authors)

Four interconnected issues stand out as being essential to developing transformative R4D systems. First, the rapid pace of change in digital technologies means that the existing knowledge divide is worsening in terms of the capacities in LMICs to invest in education, to generate and use technology and to produce sustainable innovations. This is particularly true for the ability of LMIC research infrastructures to understand the implications of artificial intelligence (and as yet undeveloped digital technologies), to plan for a future where AI is ubiquitous, and to learn how to use it effectively and equitably to solve local problems. The global open-source movement is growing and is increasingly able to create small-scale, tailored AI models, potentially disrupting the dominance of the tech giants. Supporting LMIC researchers to fully participate in the OS movement will require significant investment in computing power and capacity building, but this will greatly enhance LMIC researchers' innovative capacity and help create new, locally appropriate public goods.

Second, R4D funders could help lead the decolonisation agenda: working with partners to understand what a fully decolonised, transformative research infrastructure could look like and devising research programmes and funding modalities to support the change. This would involve paying close attention to how the polycrisis plays out in different geographies and societies, making research systems responsive to local needs while building their resilience to social, economic, or political shocks. It means moving away from the idea that LMIC research infrastructures need to catch up and converge with those in high-income countries. Instead, R4D funders could foster an approach that lets locally appropriate research ecosystems emerge based on the four key attributes of openness, equity, capability, and connectedness.

Third, the nature of the polycrisis means that while its causes may be global in nature, their combined effects are likely to span the PESTLE (political, environmental, social, technological, legal and economic) spectrum and, because of this complexity, to change rapidly and unpredictably at local levels. Research infrastructures in LMICs will need to embed capacities to help them anticipate and respond to these changes, collaborating with a range of national and regional institutions. And they will need to be able to respond effectively and efficiently to clear signals from governments about long-term priorities and funding flows to ensure LMIC researchers are able to take full advantage of what resources are available.

Finally, supporting transformative change in LMIC research infrastructures will require innovative thinking and risk taking by R4D funders. Letting LMICs do more to set the research agenda will mean re-examining and rethinking funders' roles and funding modalities. Committing to use-inspired research could result in R4D programmes that are more organic and responsive to local needs rather than fitting them around what donors consider to be important. And new funding modalities could take better advantage of all types of global funding flows to deliver step changes in R4D infrastructures in the Global South. The aim of this report is to help R4D funders consider how their own actions could disrupt current (safe) patterns of thinking about how to support research ecosystems in LMICs that would enable transformative change.
