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Keynote 1: Advancing water systems science for food security in a climate crisis

Thank you for inviting me to give this lecture. It really is an honour to be asked to give a memorial lecture for Professor Maler.
I have always sought in my career and feel most comfortable working at that interface between development and the environment where my motivation is really how do we use science in its broadest sense and very much in an applied sense to solve real problems, to solve real problems on the ground, and therefore dealing with all of the real world messiness that this implies. As you said, Somya, I was 12 years at IUCN, and I used to very deliberately get myself into trouble by saying that biodiversity is a development problem. So I'm very comfortable in this space.

Now, why such a statement would get me in trouble at IUCN is a conversation for another moment. But nowadays, I am Director General at IWMI. And at IWMI, in part, I try and encourage people to work in that space and deal with that messiness and bring science into that messy interface of how you solve real problems on the ground. As you know, our headquarters are here in Sri Lanka. I've been based in Sri Lanka for the last six years. But we have offices. We have nowadays about 15 across Asia and across Africa, including in Nepal, so are somewhat neighbours of ICIMOD. As I said, I'm no economist. I'm not going to give you an economics lecture. But I do hope that what I will cover will add value to your deliberations this week and more generally, on how you make a difference in solving real-world problems. This is one such real-world problem, which is water and water security, and why climate change means that the challenge of water security is growing harder. It's getting harder to think through how we build water security. Water security is rising on the global agenda. And as I'll cover, it needs new solutions. I'm going to run through some examples of how we are and how we can build a way forward with research for development, but also ask how we align these solutions with change across scales and systems in ways that are appropriate for that complex context in which water systems exist, but increasingly in which we're working. And how we engage with complexity in relation to development, environment and climate, and the systems that that entails, is where I'm most interested, where I find most reward. But I'll finish with the challenges, I think, for this community, for your SANDEE community, on how we bring evidence that is needed for policy and investment that will succeed in accelerating and scaling the changes needed, given that complexity.

So just in the last year, in fact, a little over a year ago, was the UN Water Conference in New York, which was the first one, first such water conference, the first formal intergovernmental conference on water since 1977. At the conclusion of that conference, as you see on the screen on the top left side, the UN Secretary General said that all of humanity's hopes for the future depend in some way on charting a new science-based course to bring the Water Action Agenda to life. The Water Action Agenda was one of the outputs of that conference. So emphasizing the critical place of water in the global agenda, the urgency of solutions, and the need for science to drive those solutions. On the right side of the screen, you see the first report from the ongoing Global Commission on the Economics of Water, and it made this point. That our collective actions have pushed the global water cycle out of balance. And this requires a sea change in how we value, manage, and use water. We must adopt an outcome-focused, mission-driven approach to water, encompassing all the key roles it plays in human well-being. So appealing for that systems-based approach, appealing for us to engage with complexity, but recognizing that as we do so, we have to think differently. The future. The changes in the diversion of water, especially for food production. And of course, climate change. Climate change is adding energy. At the core of this is physics. Climate change is adding energy to the hydrological cycle. And we experience that as increases in extreme. As you see on the screen here is droughts. In the next few slides, most of what I'm showing you is taken from the most recent IPCC assessment. So first, droughts. The frequency of them is increasing in observed and increasing in parts of the world.

The frequency and severity of droughts is projected to increase further as warming proceeds. And there are in those projections, hotspots for drought globally. South America, the Mediterranean, Southern Africa, and to a degree, Central Asia. Drought has impacts across societies and at many levels, and across systems. It plays out across the whole of the water system and the way that interacts with the food system and energy systems and so on. And of course, it affects the most vulnerable people the most severely. But these impacts include economic impacts. So on the screen is a rather neat analysis of the economic exposure, the exposure of GDP to severe drought and how that is projected to change over time, change as the planet warms. Not surprisingly, there's a substantial exposure of the economy at that macro scale to the risks of drought, and with a hotspot particularly in Asia-Pacific.
And there's a similar story at the other end of the extremes with regard to floods, increasing heavy precipitation. I suspect we've all seen and noticed that and experienced that. Changes in the return periods for floods. So in many parts of the world, those return periods falling, meaning flooding becoming more frequent in some parts of the world, the other direction. And changes in the availability of water. River flows are changing and projections of river flows increasing in some basins and decreasing in other basins. All with implications for how water relates to development, how water relates to ecosystems, how water relates to food security, etc. and compounded in South Asia by changes in the cryosphere and the retreat of glaciers, leading to what I find quite an extraordinary eye-opening projection of peak water in the basins that are fed by the water towers of the Hindu Kush Himalaya, as was highlighted, of course, in ICIMOD's report from last year on water, ice and society. Increasing river flows to mid-century and then declining water availability after mid-century, putting food, water and energy security for some two billion people at risk. It doesn't make us wake up to the imperative of new tools, new ways of managing water in the future. Then nothing.

So in these ways, in the ways that I've outlined, and in other ways, shifting monsoons, the intensity of storms, sea level rise as well, water is really the claws and teeth, the claws and teeth of climate change. But the water system is complex. Water connects. Scales, it connects sectors, it connects development and health and biodiversity and cities and agriculture and energy, connects all these things. And so climate change is reconfiguring that system, reconfiguring those connections and how we need to manage them, creating a set of very complex problems that it's up to us to find solutions for collectively.
And this is increasingly recognized. It's been really slow, astonishingly slow, to get the climate process globally to wake up to those claws and teeth, and therefore ensuring that water and the roles it plays in future climate resilience, and in many important respects, too, also in climate mitigation. To wake up to the critical role that it plays as part of, fundamental part of the climate system. But, and I've personally been involved in aspects of trying to create that influence in the climate processes for approaching 20 years. And it's really only in the last three years that is really being taken on board, that water sits at the crux of the challenges, the very complex challenges that we're all facing. So on the screen are two sets of texts from COP28 in Dubai last December. The first in the top left is the COP28 declaration on agriculture, food systems, and climate action, where there were four objectives set, and one of those was about water. One of those highlighted the critical importance of integrated management of water and agriculture and food systems to ensure sustainability and resilience. And that, it's just words, but that to me was a signal that as they drafted that text, and looked for what should be four priorities, they

identified finally water as one of those key ones. The text on the right is the Global Goal on Adaptation, the targets for the Global Goal on Adaptation that was adopted in Dubai as well. And here it lists a set of targets and there's quite a long list of them. The target that's listed first is about water, then about food, then about health, then about ecosystems, right? So identifying those core key systemic issues that lie at the heart of the climate challenge, of the adaptation challenge.

Which brings us to water security. So in definitional terms, There's a couple of definitions that float around, but the definition we like at IWMI, not least because it was authored by our previous Director General and other allies, is on the screen there. So achieving and sustaining the availability and acceptable quantity and quality of water for health, livelihoods, ecosystems and production. So both quantity and quality connecting to those different aspects of the water system, coupled with an acceptable level of water-related risks to people, environments and the economy. Risks is another key component of that. The graph on the right is taken from one of those World Economic Forum reports on risk but highlighting that water risks and water crisis is seen as having relatively high likelihood and high impact. It should be of major concern across societies.

Which brings me to the very challenging but often unseen aspect of all of this. That climate change means that hydrology is no longer stationary. The past hydrology and water management at its core is based on looking backwards into the past and saying, how have things been before in terms of how often we experience drought and flood? What do the seasons look like, When do they come? When do the monsoons come? It's been based on looking at history. And climate change means we can't do that anymore. The past is no longer a guide to future water risks. The text strapped across the slide there is from the IPCC report. It says that risks will increase with every degree of warming, which is a really innocuous statement, but it represents a really profound change to the way that we as societies engage with water and water management and this notion of water security. So the risks, the probabilities of droughts and floods, et cetera, are changing. Where they used to be stat, they used to be stationed. And the consequence of that is that we don't, as we look into the future, we don't know what they are. We can't calculate future probabilities. This is deep uncertainty. And it means that we have to retool significant parts of the way we've historically done water management. We have to make it much more based on future scenarios and understanding risks across future scenarios, and what's the best combination of infrastructure design and investment that will help us get the widest possible resilience to future risk.
But that's not all. That's not all of this uncertainty problem. The IPCC report from two years ago also included this assessment that our capacity to adapt the tools that we have for adaptation to the impacts of climate on water, that capacity to adapt falls very quickly after two degrees of warming. So as a consequence, in addition to water risks now being non-stationary, in addition, the period we have to build water security is finite. Which again is new. We've not had to deal with that before. So we have to prepare for a new water future. We have to move faster. We have to accelerate. One of the recent reports on progress against SDG6, the SDG on water, said that we need to increase the rate of progress by between two and four times. Never mind the number. We have to go faster. I think we understand. And then at the same time, climate change is increasing water risks. And those water risks have projected impacts across sectors, including, as you see on the screen, in agriculture. So this is the case across sectors.

But I want to then dive more deeply in now with a lens on one sector, which is food systems. Food and agriculture. And I do that with this simple framework for the way water relates to food systems. As you see on the screen, it has four components. The first is how we manage the supply of water into food systems. The second is how we use water for food production. The third is how we use water for food consumption, our needs for water relevant to food

consumption. And then the fourth is how we manage water risks to those food systems. I'll run through now some examples of how we can manage water in each of these components of the food system, and by doing so, help to build water security for food security.
And the examples I'll show you shouldn't surprise you. They highlight work that we have done at IWMI. But clearly, there's a vast array of such work to draw upon and build upon. And one of the points that I want to emphasize is that when we look at this challenge, there are lots of solutions out there. And a big part of our challenge is how we get them to work and work at scale. What is scalable? How does this relate to innovation systems more broadly? And how do we get them to align and start working in concert? Because we can't just solve the complex problem that I've just outlined by sort of piecemeal approaches to particular parts of this.
I'll start at the systems level. Solar, water, energy, food and ecosystems nexus. If you work in relation to water, I'm sure you've come across this nexus. It's been a hot topic for the last decade plus. But it's really just an articulation of how we need integrated systemic solutions for water and these other related systems for sustainable development. The example of this on the right of the slide is from our work in Uzbekistan. I use this example because thinking through this nexus idea in a way that's not abstract can be a bit, you can tangle yourselves up in knots sometimes trying to do that. But this example shows it very clearly. This is a context of lift irrigation systems in Uzbekistan. They're pumping water uphill to irrigate and just showing that if you change irrigation technologies to reduce water use, that reduces the amount of energy that you require in that system, reduces carbon emissions from that system. It also reduces runoff from that system and therefore pollution downstream and the way that that can impact economies and people's health and so on. So a systemic solution. Next is aquifers and groundwater. And for this, as you pointed, as you mentioned, Izabella, in your introduction, in this region, we should add to this or in the mountain region, we should add to this spring rehabilitation. So clearly, there are ways of we, as part of our responses here, managing groundwater is a critical part of that story. Including managed aquifer recharge and using groundwater as storage to buffer high flows and high-water availability and low water availability.

And the critical role then of water storage in this new water future. But thinking differently about storage, so an integrated approach to storage that works across both the conventional, traditional idea of building storage, building reservoirs, combined with natural infrastructure, so wetlands, watersheds, forested catchments, soils, and the role that they play in storing water and changing the hydrological behaviour, as well as underground water, so aquifers. The right side of the screen is also environmental flows, so how flow is allocated to meet the needs of different users in development alongside the needs of ecosystems. Fundamentally, it's a core, it's a mechanism for water allocation and therefore If we do it well and do it adaptively, a key tool in ensuring that we are able to better balance water uses across these different aspects of this complex system. And at the bottom, nature-based solutions is part of this story. So conserving and restoring ecosystem services for storage, regulation, flows, and floods, and filtration of water, et cetera. Everyone's aware, I think, that over the last decade plus, the concept of nature-based solutions has really rocketed into prominence. And indeed, in the work that we used to do at IUCN, we did a lot of work on trying to push that prominence. And so it's, I think, understood now much more so than it was a decade and two decades ago, as part of the toolkit that we need to be working with as we look at how we integrate solutions for these very complex problems.

And then finally, in this segment, reuse of water, reuse of wastewater and building in circularity into the ways that we develop and build economies. And this is in drier regions of the world, particularly in MENA, this has emerged so rapidly in the last three, four, five years. But now when you go to that region, it's just the number one thing people are focused on and talking about, is recycling water into a variety of uses, including agriculture, as a means of reducing that drawdown, reducing the pressure on freshwater resources and building resources, while, of course, also helping contributing very significantly to managing pollution and pollution loads in the environment. A really critical tool, and we'll see more and more of that as a tool as well. Moving to that second step, water for food production. Here is where we see the focus on raising water productivity. So how can we produce more food or more value from the water that is available, or better yet, by using less water? I'd say a key challenge for agricultural water management, a key challenge for how we manage water indeed across scales and manage those interactions of productivity across scales. That relates also, of course, to rainfed agriculture, something that's getting more and more attention. As people's understanding of the importance of green water flows globally and locally has been growing in the last couple of years really.

Because of course it represents a means of raising productivity and reducing food security risks and so on, but it also is a tool for reducing pressures on other sources of water as well, reducing pressures for irrigation development and so on. A critical tool that's been a bit under-emphasized, but that emphasis is re-emerging quite quickly. The third that I've highlighted here is solar-powered irrigation and farmer-led irrigation, something that IWMI does a lot of work on. I mean, just as a general principle, I think we can understand quite readily that irrigation is an important part of the toolkit that we need for managing water security in this complex future that we're facing.

At IWMI we've done work for a long time in this region that I suspect people are somewhat familiar with in relation to solar irrigation and policy innovation related to that, inclusive business models and means to mitigate some of the risks attached to solar irrigation, etc. The final point I've highlighted here is youth entrepreneurship, something a little different than the others. So here, the example I'm showing is to do with action research that we've been leading with young entrepreneurs in northern Ghana on developing an aquaculture industry, another way of raising water productivity, in a sense, but also a means of addressing both economic challenges, particularly for young people, and ensuring that we are strengthening the climate smartness of food systems as we look into the future.

Okay, so the third component around water for food consumption, and what we're referring to here really is recognizing that for good nutrition and health, drinking water and clean and safe drinking water is fundamental. It's amazing how often that connection is not made. Maybe that's just especially trying to get people to understand that it goes in the same mouth and the same stomachs. And if you're going to gain that nutrition and gain the benefits from that good quality diet, then you need to have good quality drinking water and sanitation systems around you as well. Also, of course, relates to water for cooking and the way that relates to management of household water and so on. So finally, this point about water risks, this key issue that I've been highlighting in relation to water risks, and here we need to be looking toward how we retool It's the term, how we retool the way that we manage water risks as we look into the future. Because if the past is no longer a guide to future water risks, then we're going to need much more real-time information about water risks, as well as much more regular and constant updating of projections for future water risks. So increasingly at IWMI, but across a whole range of water researchers, there's this emphasis on how we can best enable a much more risk informed planning for future water that enables us to identify what are the future options for infrastructure, for investment, for management, indeed for policy as well, that are going to help us be have water systems that are robust to future water risks that will be effective across a range of possible futures, combined with the flexibility that will be key to adapting as we go along. Some of the tools for that, that we're working with Drought and flood monitoring, of course, is key, and that's not new, but it becomes a critical tool. It is a critical tool in doing all of this. Increasingly, there's AI applications in helping us make forecasts more effectively for drought, especially, that we're involved in. Water accounting, so how much water do you have? Where's it going? How's it being used?

Using tools that combine earth observation and modelling to help us do that, gives us the possibility of having near real-time water accounts, which will be a really important tool for this challenge, so that we can, as we look into responding to water risks, target our management of water risks changes in water productivity, etc. Do so with use water accounts in scenarios, understand how water accounts change with different future scenarios to as input into that risk-informed water resource planning that's increasingly so critical. On the bottom row of what I have on the screen is a new-ish set of products from IWMI that we call the AWARE platform, which is an early warning decision support system that integrates a whole range of different information systems to help decision makers understand, identify and understand where they should be investing in anticipatory action, what anticipatory actions they should be taking when there are extreme events, droughts, floods, etc. coming. This kind of tool, as we look into that new future, becomes more and more important, and particularly in the fragile parts of the world where increasingly, actually, IWMI is working and increasingly being called upon to work. And the final point here is digital twins for basin management. Digital twins. Here we're referring to AI-enabled platforms for integrating modelling and all sorts of data sources in a basin to help drive help support decision-making in near real time, as well as that risk-informed planning challenge. We're working on a digital twin for the Limpopo Basin, which is teaching us a lot. Our partners in the Limpopo Basin in Southern Africa are super enthusiastic about what's emerging here. We're very excited about it. It's really breaking new ground. In the application of these kinds of technologies. Let's see where that goes over the coming period. It's moving very fast, that area, not surprisingly.

All of this, all of those examples, all that way of looking at the way water security relates to food security and what we might do about it, it all sits within this wrapper of complex systems. And it's very easy to underestimate and just talk about those kinds of innovations and those kinds of areas of technological innovation, of new risk tools, etc. It's very easy to just talk about those things and forget about the wrapper, the wrapper of complex systems and how do you work with change in those complex systems is through institutions and through governance and through equality and inclusion and how we align those in order to catalyze and manage and achieve the kinds of systems level changes that we need to do. It's all one package, right? One package.
And what I've highlighted are some of the threats for how we build water security for food security. And I described it before as one lens on the problem. It's one lens in a sense of, in a set of what we term wicked water problems. We highlight five of these wicked water problems, which you see on the screen. One is the way water relates to hunger, which we've talked about a little bit; the way water relates to climate beyond two degrees, this challenge of what happens when we run out of options for adapting; the way water relates to poverty and exclusion, this challenge of deep uncertainty; and the way that water relates to ecosystems and ecosystem breakdown. Our solutions, the solutions that we're working with, they need to be relevant to and they need to enable progress across these problem sets because this changes what's possible and what's not. One example of that is this, what can be a vexing question of should we be working towards moving water out of agriculture? And I like to use this slide because it tells us how little we know. As well as when we change the problem set, how radically the possible solutions change. On the left side is text from that same IPCC report that I've been highlighting today. And it says that depending on your underlying assumptions and the constraints on water resources in the global agricultural models, irrigation water requirements are projected to increase by two to threefold by the end of the century.

Triple the water use that we use for irrigation now. It's what they're projecting in the IPCC report, right? On the left side, the right side, when we introduce into the problem space that we're working with, we introduce how are we going to feed 10 billion people and do it within planetary boundaries? Then the answer is hugely different. Their answer is we need to cut globally, cut water use for irrigation by 7% about 10%, right? We need to cut as well as shift irrigation from parts of the world where future water availability would be unreliable to new parts of the world, right? Simple words to say, but underlying that are huge challenges, right? My conclusion from looking at those two things is we haven't got a clue what we need to be doing, right? So how do we proceed?

Okay, so just to wrap up then. There's this new urgency around water security. Water security is getting harder. There are solutions available, but these solutions, they have to work in concert. They have to work systemically. We have to integrate them across, as I showed you, in the case of food, the different components that are relevant to water security for food security. To do that, the governance and institutional frameworks, which I rather underemphasize than what I've said today, but they are the foundation for creating the change that we need to tackle this problem space of water security getting harder as we move into the future. They're the foundation for doing that. There is within that a set of core challenges for a community like yours. How do we integrate solutions across wide diversity of users and uses, across scales, often forgotten in other disciplines, across scales, and across that set of wicked water problems? How do we do that? How do we prioritize and advise? Two years ago, I was in Nepal and met with the Minister of Water Resources, Irrigation and Energy. I'll get that mixed up. And I sat down, and the first question he asked me was, he said, how will we manage future water risks? And it was such a surprise that he was right on the nose about what he wanted from us. And it's such a key question. So how do we advise that minister? How do we advise the way the World Bank in this context will prioritize its investments relative to this kind of systemic change that we have to drive?

I think we have to have the courage and the boldness to think radically about how we do this. I'm very taken by the notion of using this, as I mentioned at the start, the report from the Global Commission on the Economics of Water, advocating for a mission-driven approach, mission-driven collective action on water security, where missions are about how do we bring together coalitions across different aspects of society, of which science and research is one part, bring together coalitions on common priorities, and do so across the innovation system, so we can talk about what we mean by the innovation system. But mobilizing societies for that mission of delivering this kind of change. Final slide. In IWMI, we just adopted a new strategy, just launched a new strategy in the last few weeks. I won't go through it, obviously, but it represents how we're taking on the set of challenges that I've outlined today. Our three big focus areas are risks, as I've talked about a lot, inequalities, and sustainability of water. So how we manage water across all those different uses, make sure that it's inclusive in the way that we do it, and that we're able to manage for future water risks in ways that are going to work for this very different water future that we all face.
Thank you.