

# CPWF TOPIC 4

## synthesis

# Global Drivers and Processes of Change

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## Global Drivers and Processes of Change: Topic 4 Synthesis Paper

### CPWF Topic Synthesis Papers

In the second phase of the CGIAR Challenge Program on Water and Food, activities will be organized around Basin Development Challenges and Topics. Basin Development Challenges are water and food problem areas of recognized importance in a river basin area. Topics are subject matter areas selected to support research on basin challenges. Topics play two roles: to ensure the quality of science in research on basin development challenges, and to facilitate the development of international public goods.

The process of jointly defining basin challenges and topics began with stakeholder surveys, and consultations with Basin Coordinators, Basin Focal Project teams, Phase 1 Theme Leaders, and external experts. This process culminated in a series of one-on-one interviews with key basin stakeholders from research, development and policy arenas.

In their present form, the priority Topics are as follows:

- Improving Rainwater Productivity
- Multi-purpose Water Systems
- Water Benefits Sharing for Poverty Alleviation and Conflict Resolution
- Global Drivers and Processes of Change

The four synthesis papers describe these priority Topics: their present status, how they evolved, what was learned about them in Phase 1, and the kinds of research likely to be needed on each topic in Phase 2.

These papers are not the final word, however. Basin challenges and topics will continue to be re-defined. Topics are intended to support and serve the basins: as research on basin challenges unfold, the content of individual topics may be modified. Whole new topics may emerge and other topics dropped.

I wish to thank Theme Leaders who have put tremendous effort into these papers, as well as others in the CPWF community, who together have made this document possible.

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## Introduction

The aim of the Challenge Program for Water and Food (CPWF or CP) is to contribute to global efforts to increase food production to achieve internationally adopted food security and poverty eradication targets by 2015. It does this by working in selected river basins across the developing world to address promising and under-researched water-for-food issues confronting countries and communities in those basins. Its approach is not a traditional one in that it takes a value-driven point of view and attempts to go beyond simply conducting studies by actively promoting promising findings, aiming at influencing decision makers and informing their choices.

In addition to the issues, termed development challenges, identified by basin research teams as areas of study, the CP also organizes its activities in terms of cross-cutting topics. These topics help to support basin research teams in understand basin level issues, and in some cases, may guide research that cuts across basins or scales. Four principal topics are being addressed during Phase 2 of the Program: (1) rainfed agricultural productivity, (2) multi-purpose water systems, (3) sharing water's benefits, and (4) global drivers and processes of change. The last of these topics is described here.

The role of the Topics is to facilitate and channel high quality research, promote cross-fertilization among basin studies and researchers, and integrate and generalize results across basins and scales. Topic 4 has a special additional responsibility in that it helps to examine the potential collective impacts of outscaling innovations studied and promoted by basin research teams.

This paper first examines the rationale for addressing the principal issues subtended by the topic. It then looks at the results of work carried out during Phase 1 related to this topic and identifies important gaps in our understanding related to Topic issues. It then describes a set of research areas and related questions addressing these gaps. Finally, it examines the comparative advantage of the CPWF in studying these issues.

## Rationale

A driver is any natural or human-induced factor that directly or indirectly influences the future of agricultural water use. Drivers are sometimes categorized as 'indirect' and 'direct'. Indirect drivers include demographic, economic, socio-political, scientific and technological, cultural and religious, and biogeophysical changes.

Important direct drivers include changes in food con-

sumption patterns, natural resource management, land use change, climate change, energy and labor. Changes in these drivers affect how people can access and use water for food production, both directly and via changes in investment in the agriculture sector.

Here a somewhat different way of distinguishing drivers is employed. While drivers in general are defined as above, a set of global drivers is distinguished. Global drivers are (a) powerful and long-lasting, (b) wide in scope, and (c) beyond easy control by individual countries or groups of countries. Prime examples are a globalizing world economy, climate change, and demographic transformation, which results in the great bulk of population growth in the world today occurring in urban areas. Other "non-global" drivers are generally much more subject to manipulation by policy decisions and investment.

'Change' in our terminology means developmental change through behaviors and policies aimed at improving food security, reducing poverty, and increasing water productivity. "Processes of change" means the way in which change is stimulated, guided and achieved, with particular reference to the role of research.

### Global drivers of change affect water and food security

While food and water security is largely determined by actions taken at the local or national scale, global factors, such as world food trade, global climate change, demographic changes and competition for water, also affect food and water security at the local level. Over the coming decades these global changes will affect food and water security in significant and highly uncertain ways, and there are strong indications that developing countries will bear the brunt of the adverse consequences. This is largely because poverty levels are high and developing country capacity to adapt to global change is weak.

Furthermore, the rural populations of developing countries, for whom agricultural production is the primary source of direct and indirect employment and income, will be most affected due to agriculture's vulnerability to global change processes. Important economic factors include lowering trade barriers, perhaps partially offset by rising energy prices, biofuels, increasing global trade in food grains, rising costs of fertilizer as well as rising commodity prices, increased multinational investment in food processing industries in developing countries, development of local agricultural value chains. Long-term changes in climate will disproportionately

affect regions in tropical zones, countries where a majority of the population is employed in agriculture, where rainfed agriculture is the predominant agricultural production method. The agricultural sector in most countries is the largest consumer of blue water resources, and variability in water supply has a major influence on health and welfare in poor areas. With extreme weather events expected to increase almost everywhere under climate change, and water scarcity likely to increase across lower and middle latitudes, water security could decline significantly in rural areas. Moreover, human alteration of land use patterns, urbanization, elimination of wetlands, nutrient overloading in water systems, and other biophysical changes, could dramatically affect the ability of the global water cycle to support needed food production. Consequently, it is important to understand the impacts of global changes on agriculture and natural resources in developing countries and to develop adaptive capacity to respond to these changes. This work will be implemented together with the CGIAR Challenge Program on Climate Change.

The development of policies that enhance food and water security at the local level, mitigate adverse and enhance positive impacts of global change, and support adaptation to climate and global change therefore requires an understanding of the interaction of local, basin-scale, national, and global factors. Analysis of strategies for increased food and water security must take into account the relevant hydrologic, agronomic, economic, social and environmental processes at the global, regional, national, basin, and local levels.

### Linking research and developmental change

The CPWF aims to move beyond pure research and seeks to influence decision makers – from farmers to high level policy makers – with the results of its research. This leads to the need to better understand how research links with decision making.

One way the CPWF will develop understanding of how its research catalyses change processes is by researching how different types of research outputs and knowledge do (or do not) move along impact pathways in different contexts, and what types of partnerships are required to achieve developmental outcomes and impacts. Impact pathways are a set of propositions, or hypotheses, about how a project or program has changed, or will change stakeholder knowledge, attitudes and practice, and influence decisions. They map out the steps between changes in stakeholder practice, i.e., outcomes,

and social, environmental and economic impacts. The CPWF employs an evaluation system in which impact pathways are identified at the outset of the project, regularly revisited during project implementation, and then used as the basis of ex-post impact evaluation.

The CPWF will add value to this project monitoring methodology by using the information collected to test impact hypotheses. In impact research, projects are seen as experiments in which project implementers attempt to trigger change mechanisms using research outputs, and the conduct of research. The project will attempt to derive general propositions and conclusions from this research.

Monitoring and evaluation relative to CP research activities provides intelligence about processes of change ‘close to’ the Basin Development Challenges (BDCs). It does not provide intelligence about longer-term trends occurring in basins and globally, nor provide broad-scope understanding of the political economies in which the BDCs are embedded. More fundamental analyses are needed to understand the broader processes of developmental change and policy and program decision making, which establish the environment in which shorter-cycle decisions are made.

## Contributions from Phase 1

During the first phase of the CPWF, a variety of research contributed to global and basin scale research, including work by individual projects, Basin Focal Projects, Theme 5: Global and national food and water system, and Impact Pathway Project.

### Global drivers of food and water security at the basin scale

Basin Focal Project (BFP) studies in nine benchmark basin plus the Niger conducted during Phase 1, provide detailed insight into the conditions of water distribution, its use in agriculture, and linkages between water, agriculture, and poverty. Analysis emerging from these basin studies highlights two key factors – the effects on livelihoods of water availability for agriculture and other activities and the effectiveness of the agricultural system to support people. But analysis also shows relationships to be highly dependent on scale and location. This has major implications for our understanding of specific change processes that research supports.

### **ADAPTING TO CHANGES IN THE GLOBAL WATER CYCLE**

A project on “Food and water security under global change: developing adaptive capacity with a focus on rural Africa” (PN53) aimed to provide policymakers and stakeholders in Ethiopia and South Africa with tools to better understand, analyze, and formulate policies to facilitate adaptation. The project used household surveys, focus groups, scenario development, and food and water supply and demand modeling to uncover the risks posed by climate change, identify vulnerable groups and better understand adaptation processes. Results indicate that vulnerability depends on a number of factors including the socioeconomic characteristics of the household and region. Furthermore, several factors constrain households’ ability to adapt their farming practices in response to climate change, including lack access to climate information and extension services, lack of access to credit, and the economic position of the household. Therefore, governments should not only support research to develop and promote new technologies, such as water storage, irrigation, and improved crop technologies; but should also address market imperfections, like access to information, credit and markets, and provide better information and rural services to small-scale subsistence farmers.

### **EFFECT OF SCALE**

At a global scale, food and water systems seem to operate almost independently. People talk of a global water crisis, and a global food crisis. Few commentators stress the crossover between these systems. At a local scale, food and water are linked strongly by features such as water use and productivity of crops, by competing demands from crops, livestock fish or people, and by the effects of reservoirs on food security. But such processes are rarely related to external systems. It is at a basin scale that these factors tend to come together, through complex interactions of water and food systems.

Insights into such scale-dependent processes and the institutions that influence them are essential to definition of change processes we wish to influence. Some examples:

Small reservoirs are seen as important for development of higher-value cropping systems in the upper Volta. Do they have an adverse impact on flows into Lake Volta or other reservoirs? If so, how will this effect regional and local development prospects?

Two-thirds of people in the Mekong basin rely on fish for livelihood. In the Tonle Sap, people are almost totally

dependent on aquatic systems that are influenced by development in other parts of the basin. Upstream changes in flow, brought about by hydroelectric development, influence basin-scale process that affect peoples’ livelihoods downstream.

Attempts to provide relief to drought-stricken areas in the Sao Francisco basin are part of a national poverty alleviation strategy. Such changes promise local benefits but threaten critical flows in the main river and have met fierce opposition.

### **WATER USE WITHIN BASINS**

There are major contrasts that influence how people use water within the ten BFPs and what are realistic options for improved use. Desirable change relates to the relative importance of different water uses, and the institutions that control them. Basic variables include water availability per capita, total volumes and sensitivity of flow to upstream change. Livelihoods systems vary accordingly, and indicate the scale of opportunities for change.

Hydrology determines the broad land use options. For example, flow patterns in the Mekong provide huge volumes of water that support fisheries on which most people in the basin depend. Conversely, livestock is the major water user under more droughty conditions in African basins. These relatively small improvements in water use by livestock promises greater total gain than similarly-scaled improvements in irrigation systems.

### **WATER PRODUCTIVITY**

Water productivity is a fundamental indicator of performance of agricultural water use and can be used to diagnose opportunities for change and speed of change. Data from BFPs shows that water productivity is generally well below potential. Within the Volta basin, crop water productivity is usually less than 10% of potential, and static. In more intensively managed basins in Asia, productivity is higher. More importantly, data indicate that in some areas water productivity is increasingly strongly as the systems respond to increasing demand. In the Mekong delta, for example, the past 15 years have seen strong growth of maize water productivity to reach about 50% of potential. The Sao Francisco basin in Brazil shows a strong contrast between the performance of commercial and subsistence farmers. In the Karkheh, change follows an unusual trajectory depending on access to markets for higher value crops.

**WATER RIGHTS**

Through a project on “Multi-scale Mekong Water Governance: Inter-disciplinary Research to Enhance Participatory Water Governance from Local Watershed to Regional Scales” (PN50), explored how participation, rights and access to water can be established and safeguarded for the poor, women, and other socially excluded groups in the process of global change. Through action research on fisheries, flood management, irrigation, hydropower upper watersheds, and water works in the Mekong Basin, PN50 highlighted the importance of multi-stakeholder governance arrangements in allowing communities, stakeholder groups, and societies to cope with and adapt to complex changes.

A Theme 5 synthesis book highlights three steps that can enhance water rights and access by the poor: 1) Redesigning governance—forming more inclusive forums to negotiate agreements and rules; 2) Resolving tenure—establishing rules and other institutional arrangements to clarify rights and settle disputes; and 3) Regulating transfers—implementing routine mechanisms for temporary and permanent transfers of water access, with relevant safeguards.

**INCENTIVES, INVESTMENT AND FINANCING OF AGRICULTURAL WATER DEVELOPMENT AND WATER SUPPLY**

Research to examine how large scale investments could increase water and food security in Ethiopia was commissioned by Theme 5. The resulting research is presented in CPWF Working Paper 1: An Assessment of Investments in Agricultural and Transportation Infrastructure, Energy, and Hydroclimatic Forecasting to Mitigate the Effects of Hydrologic Variability in Ethiopia, by Paul Block. The paper demonstrates the importance of consideration of complementary investments to strict water investments.

**Contributions from Impact Pathways Research**

Impact pathways activity during Phase 1 has focused strongly on developing methodologies for tracing and assessing the impacts of CP research.

The CPWF’s Impact Project developed Participatory Impact Pathways Analysis (PIPA) for describing and monitoring research projects’ effect on developmental change. The project held eleven CPWF workshops in eight river basins, during which more than 200 CPWF project implementers constructed impact pathways for

their projects. In addition to its use within CPWF, the PIPA approach has been adopted by CIP, WorldFish, ILRI, Bioversity, CIMMYT and ICRISAT. PIPA is being used in an EU-funded project working with universities in Argentina, Uruguay and Mexico. An article describing PIPA has been published in the Canadian Journal of Program Evaluation (Douthwaite et al. 2008).

The PIPA methodology will be applied in all phase 2 research projects as a program management tool. Additionally, it will be used as a standardized source of data to inform a centralized learning process that will attempt to draw out generic lessons about conditions under which research can most effectively influence development decision making.

During Phase 1, the CPWF also developed a methodology for determining the most suitable locations for applying piloted innovations. The methodology, termed extrapolation domain analysis (EDA) uses a spatial analysis technique that combines Bayesian (weights of evidence) and statistical modeling (multivariate techniques) to determine the potential of different environments to adopt innovations demonstrated in pilot study areas. The method assumes that sites with similar climatic, landscape, and socio-economic characteristics are more likely to adopt than those that are less similar. Climate characteristics include rainfall, temperature, and evapotranspiration, plus more than 30 derivative indicators. Landscape features and socio-economic attributes such as land use and poverty are also considered. The search field is global, focusing on the tropics and sub tropics. Regions are then associated with different probability levels of similarity with the pilot site. EDA is expected to be employed under the “outscaling” research area of Topic 4 during Phase 2.

A central tenant of the CPWF has been that there is added value to research if food and water institutions work together. An impact project study of the ability of CPWF funding to increase collaboration among food and water research organizations found that CPWF funding is strongly associated with a likelihood that food-related and water-related organizations will share a research, scaling out, or scaling up linkage.

Ex-post impact assessment is helping to understand what this brokerage leads to in practice. For example, an integrating livestock, water and land management technology has increased water and livestock productivity for 17 households in Uganda. The success in part due to the CPWF helping integrate water sciences into the traditional Animal Science curriculum at Makerere University.

# Remaining gaps

## Aiming for the future

Global drivers of change, such as global warming and associated climatic changes, the emergence of a globally connected economy, and population growth which is concentrated largely in urban areas, are rapidly changing the context in which future decisions will be made. As a consequence, applied research aimed at development solutions must be aimed not at conditions presently prevailing, but those expected to exist some 10 or more years in the future. Needed is an analysis of the role of global drivers for basin-level water-for-food issues that includes integrated modeling at the basin level to bring together these global drivers, along with local driving forces, to develop a range of future contexts in which the decisions stemming from CP research will have to play out. This will guide the identification and framing of research questions and suggest important dimensions to include in CP studies.

## Linking research and developmental change

The specialized process of conducting research targeted specifically at particular types of developmental outcomes requires clear and strong linkages with decisions taken by public officials at national and sub-national levels, as well as lenders, NGOs, commercial firms and end-users. These linkages must be two-way. Results of Sound CP research must reach the hands of these decisionmakers in a form that is convincing. In addition, however, the priority problems and needs being addressed by these decision makers must play a strong and guiding role in framing CPWF research topics and questions. How best to make these linkages with different types of knowledge and technology generation in different contexts remains a research challenge.

## Out-scaling

Much CP research, particularly that falling under Topics 1 and 2, is carried out at community and local scales. Before promising results of such research can be recommended for widespread introduction, the scale effects of the innovation need to be assessed. The assessment should include possible limits on water supplies, on possible unintentional pirating of water in existing uses, on possible market saturation effects, and so on. This requires identification of key dimensions of potential scale effect problems, followed by assessments of the cumulative effects of "extension success" in introducing the proposed innovation. At the same time impact pathways need to be traced out and possible partnerships identified.

## Translating ideas into programs

Once scale effects of promising innovations are examined and out-scaling found feasible, the innovation needs to be translated into a program, to show how it could be introduced at scale. This involves identifying the changes in policies, laws, and institutions required to introduce and support the innovation, along with investment requirements and modalities. At the same time, extrapolation domain analysis can be carried out to identify particular contexts in which the introduction is likely to succeed and be sustained. While governments and lenders who actually introduce and support such projects will do their own careful analysis, the CP needs to sketch the outlines of such a program to show that introducing the innovation is feasible and practicable.

## Research Program Objectives

*The objectives of Topic 4 research are to:*

- Identify the medium-term future context of life in rural areas, including the opportunities and threats posed by emerging global changes
- Anticipate and measure the downstream and cross-scale consequences of expected trends in water use and water management in CP basins, and the larger-scale consequences of out-scaling CP innovations
- Suggest implications of these analyses for policy making and institutional reform in selected basin countries
- Help the CPWF and other projects and programs operating in complex environments to understand how knowledge combines with power, political interests, non-water sectoral policies and priorities, cultural and other factors to influence action in economic development and adaptation to global changes
- Generate IPGs related to policies, institutions, investments and change processes useful to the larger research community and beyond
- Contribute to building the external recognition and influence of the program

## Scope

The geographic unit of analysis under Topic 4 is generally the basin, or individual countries within a basin. IPGs created under the Topic would, by definition, be more universal, but would still typically address issues at national or basin scales. Topic 4 will necessarily work

closely with the other Topics to address context, scale, and research/development relationship issues. While a significant portion of CP research is local in scale, ultimately, a research program of the scale of the CPWF must be able to generalize its results into forms that will speak to national decision makers and donor agencies. Topic 4 offers a vehicle to make this local to national connection. However this cannot happen unless local-scale research under the CP is structured and organized from the beginning so as to allow such generalization to take place. This means, among other things, placing a great deal of emphasis on developing a robust classification system for contextual variables and for employing these classifications consistently during project design.

### Research Areas and Guiding Questions

Research to be conducted under Topic 4 can be broken down into three areas.

#### **ANTICIPATING GLOBAL CHANGE IMPACTS ON WATER AND FOOD SECURITY**

The combination of a globalizing world economy, a changing global climate, and large-scale demographic trends have profound implications for rural residents in developing countries, particularly the poorest of these. Theme 4 will develop techniques to estimate and combine these impacts, and link them with the traditional dynamics of rural economies, to analyze alternative future configuration of the environment in which the challenge of improving rural livelihoods and preserving ecosystems with limited amounts of water must be met.

*Key questions include the following.*

- What future hydrologic, economic, and social conditions are anticipated in CP basins under alternative climate change and development scenarios?
- What are the implications of alternative scenarios for CP research topic selection?
- Who does the cast of winners and losers change in response to global change?
- How can capacity to analyze global change impacts be institutionalized in CP basins?

#### **PROJECTING SCALE EFFECTS OF INNOVATIONS**

New innovations for improving water productivity, increasing incomes of the poor, adapting to a changing climate and other global drivers of change are usually identified and tested on a sub-basin scale. Before recommending these innovations for wide-spread introduc-

tion, however, it is necessary to consider their impacts when applied on a larger scale. This requires assessing collective impacts on water supplies, as, for example, in the case of multiple use water systems, where quantities delivered to numerous households would be increased to accommodate productive as well as domestic use. To take another example, it would also require assessing the impacts on local markets for horticultural crops, where a higher value cropping pattern is proposed. The impacts of climate change will operate most strongly through their influence on the hydrologic cycle. These hydrologic impacts, together with rising temperatures themselves, will powerfully affect developing country agriculture, broadly defined to include crops, livestock, and fish. Topic 4 research will examine the finer detail of these impacts through hydrologic and agronomic models driven by the climate results. This will allow improved prediction of likely climate change impacts on particular crops and animal species, and on their producers. Research under this topic will link with that under the new Climate Change Challenge Program (CCCP), once that program is up and running.

Research under Topic 4 will assess the effects at basin scale of proposed innovations, both those developed by the CPWF and promising innovations proposed by other researchers. Analyses will include consideration of important climate change impacts on hydrologic and agricultural systems.

Key questions include the following.

- What scale effects need to be considered when considering an innovation for basin-wide application?
- What are these scale effects for important proposed innovations in each CP basin, including the identities of winners and losers among stakeholders?
- How can negative effects of outscaling be reduced and positive effects enhanced?
- How can regions most suitable for outscaling particular innovations be identified?
- Will proposed innovations, when outscaled, improve resilience to climate change?

#### **LINKING RESEARCH TO DEVELOPMENT DECISION MAKING**

Research-for-development can, by definition, only be effective if it succeeds in influencing and supporting policy and program decisions of national and sub-national governments. Ultimately, it would be desirable for this influence to extend to basin-level governance as well, but

this must await the emergence of such arrangements in most basins.

This raises the question of how best to organize research and relationships to achieve such influence. For this to happen (a) the research must be sound, (b) it must be relevant to decision makers' concerns, and (c) it must reach them in a form that is practicable and convincing, which in practice often means including potential users of research results in the research. Research under Topic 4 will attempt to design research practices and relationships that address points (b) and (c) above.

Research will consist both of very applied activities to develop improved practices for research design and sharing that maximize relevance to decision makers and more basic research on the political economy of policy and program level decision making<sup>1</sup>.

*Key questions include the following.*

- How does scientific knowledge interact with other factors in decision makers' thinking as they select policy and program directions?
- How can priorities for adaptive research on water and food be attuned to the issues of greatest concern to decision makers?
- What are effective strategies for maximizing research impact?
- What types of bridging institutions are needed to link research and decision making?
- How do you build capacity in carrying out research in ways more likely to lead to uptake and use?
- What conditions facilitate inter-governmental cooperation and decision making?

## CPWF niche and value added

The CP is an international, multi-dimensional research-for-development initiative, with a joint concern for water and food problems. This is a special combination of characteristics that distinguishes the program from most

<sup>1</sup> Note that the concepts of "policy" and "programs" are equally relevant at national, sub-national, and community levels, though degrees of sophistication would obviously differ.

other research on water and food issues in the developing world.

The endogenous concern with "what happens" to the research results produced by the project offers a unique opportunity to examine research impacts, in addition to researchers' traditional concern with peer-reviewed research quality. Topic 4 includes studies on how research results influence development decisions and on how and under what conditions project innovations can be successfully introduced in new geographic areas. It also includes more fundamental research on the political economy of development decision making, and case studies of non-CP food and water research projects which have successfully impacted development decision making.

Another unique feature of the program is the clustering of its research within a set of selected river basins. Just as employing basin boundaries for management purposes enhances the potential for sound integrated water resource management, employing a basin focus in research design can produce research results that are more integrated across regions and topics and better keyed to the hydrologic characteristics of the basin.

This potential is realized, however, only if the hydrologic interconnections among projects and regions within a basin are explicitly recognized and incorporated into the integration process. Without this extra step, a basin-based research planning process possesses no particular advantage over alternative ways of organizing research<sup>2</sup>.

Topic 4 addresses this need to consider basin hydrology as an integrating factor by emphasizing careful analysis of the outscaling potential of CP innovations and the combined impact on basin water resources.

This is particularly important for small-scale community focused research under Topics 1 and 2, but also an important and integral consideration for research on benefit sharing. Analysis of hydrologic interconnections extends to both quantity and quality dimensions of the resource and includes both ground and surface water, including reused water.

<sup>2</sup> In fact, it may be inferior, since policy decisions are typically made on a national or sub-national basis. The fact that basins cut across political jurisdictions is thus a negative trade-off against the hydrologic advantages of a basin focus.

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