



LA SEGURIDAD DE PRESAS ANTE EL CAMBIO CLIMÁTICO

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158 del ICOLD**

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COMMISSION INTERNATIONALE
DES GRANDES BARRAGES

INTERNATIONAL COMMISSION
ON LARGE DAMS

**EL ICOLD
DESTACA EL ROL DE
LOS RESERVORIOS
PARA LOGRAR UN
DESARROLLO
SUSTENTABLE**



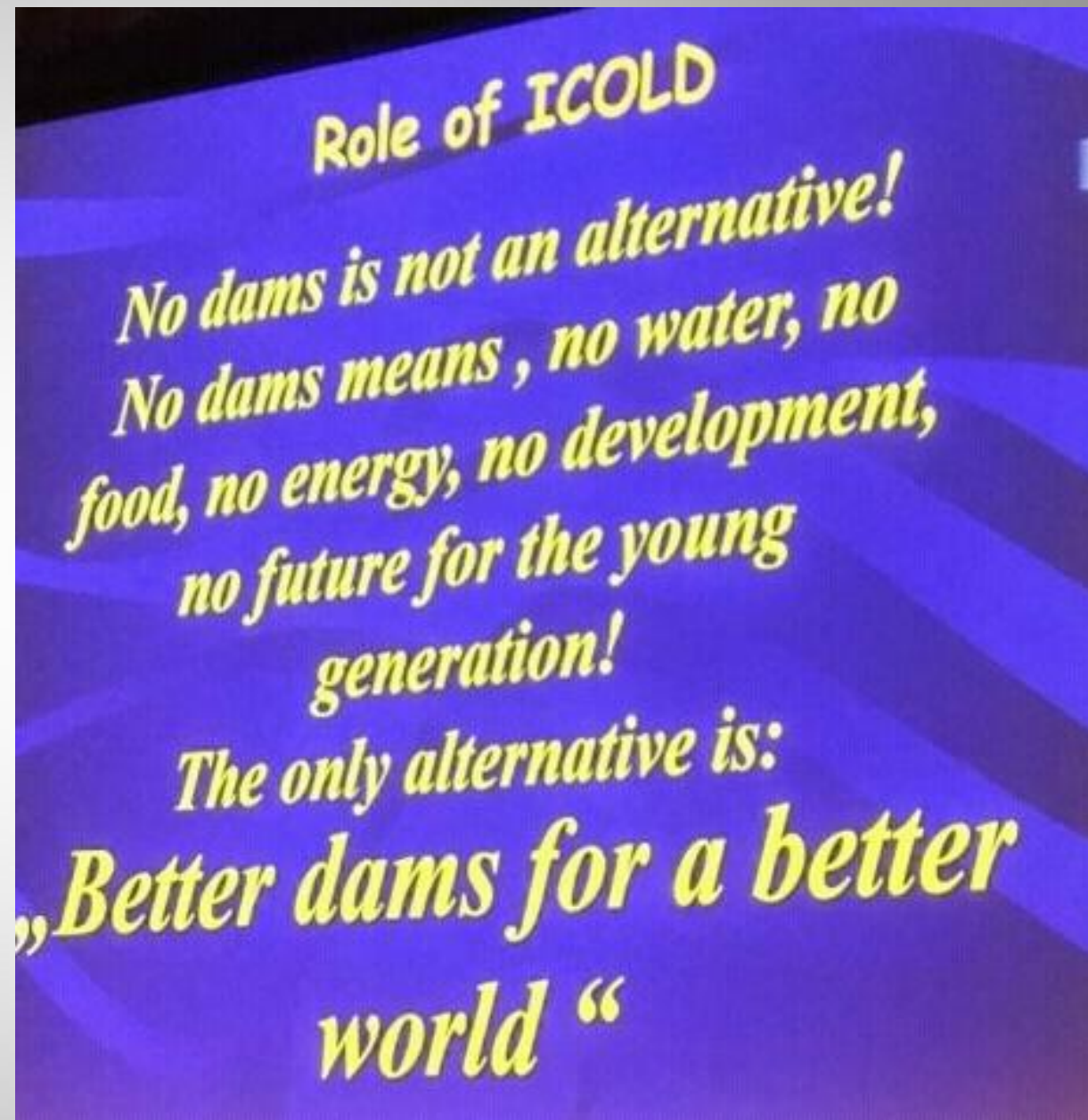
ROL DEL ICOLD

¡No a las presas
no es una alternativa!!!

No a las presas significa, no
agua, no alimentos, no energía,
no desarrollo, no futuro
para las jóvenes generaciones

La única alternativa es

“Mejores presas
para un mundo
mejor”

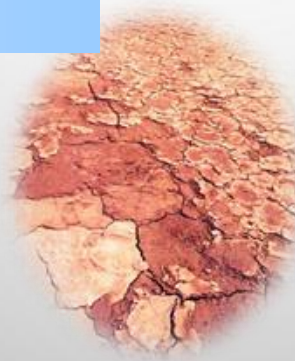
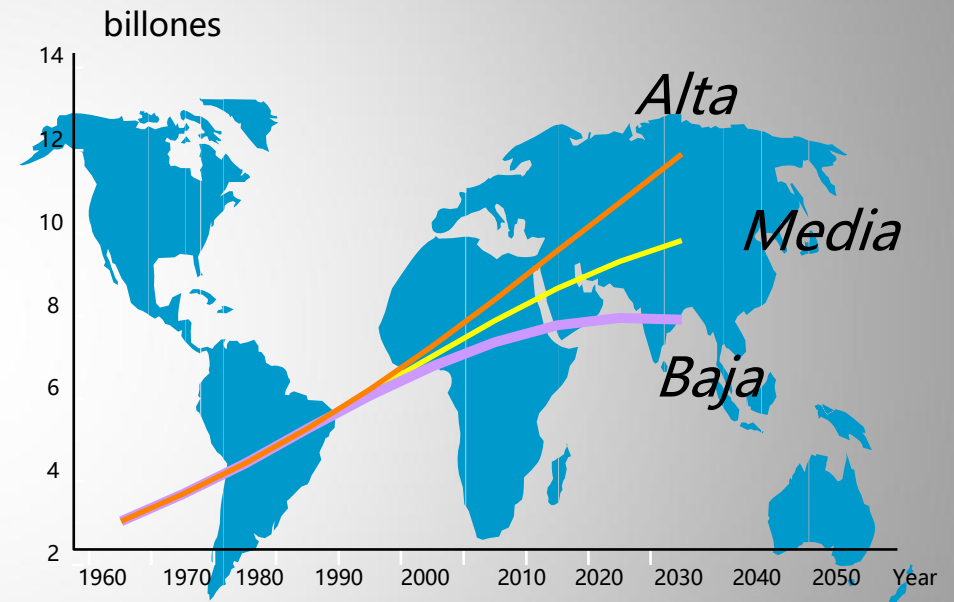


El mundo en rápido desarrollo

1 Crecimiento de la población y la urbanización

2 La recuperación económica y el desarrollo

3 La seguridad ecológica



2003

Problemas graves en materia de disponibilidad de agua y de seguridad energética

1.1 billones falta de seguridad
de agua potable

2.4 billones falta de servicios
sanitarios

2.0 billones falta de provisión
de energía

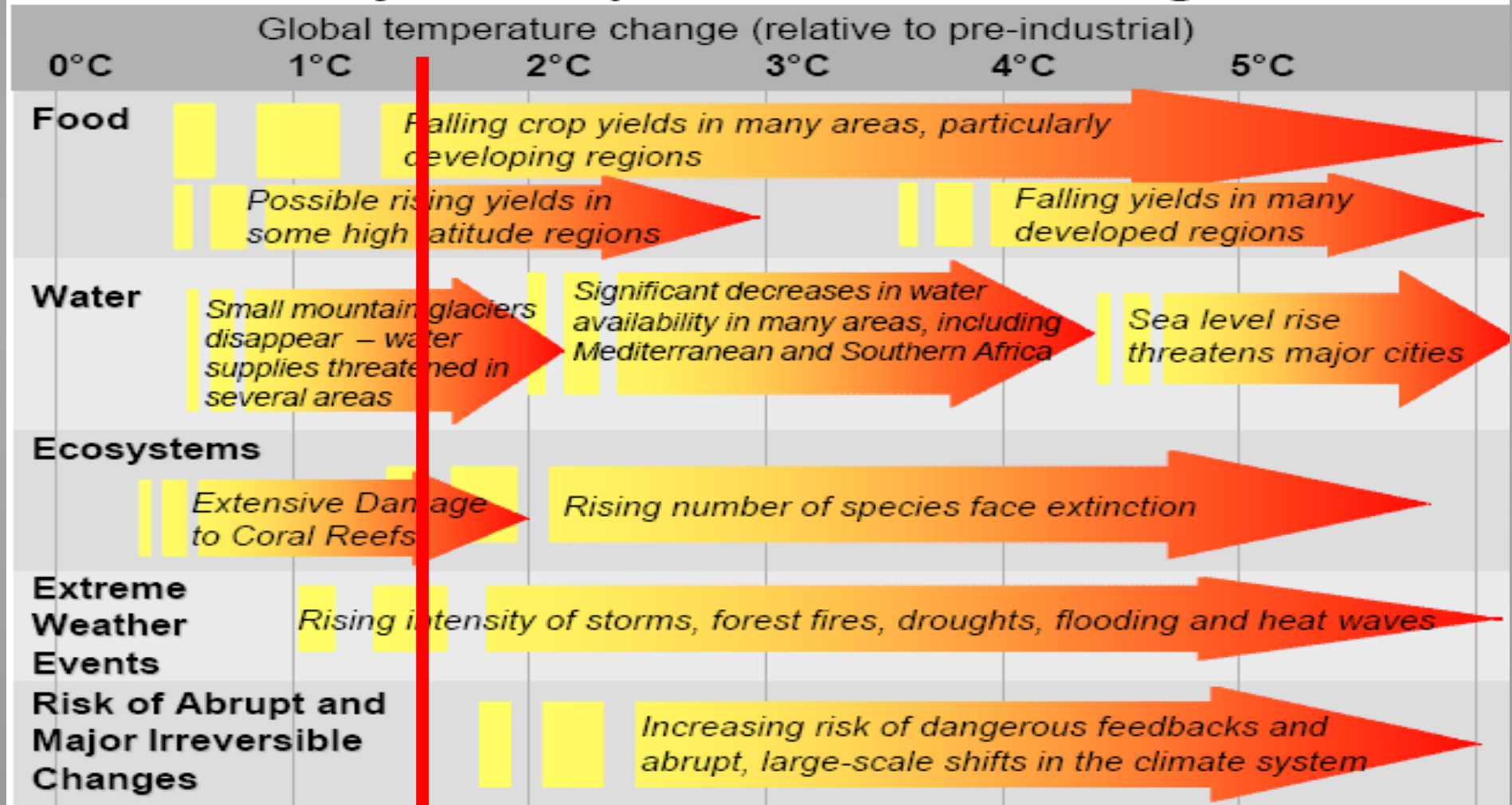
0.21 billones sufrirán desastres
naturales cada año

¿ Cómo nos
adaptamos a las
exigencias
de desarrollo
y al
cambio
climático?

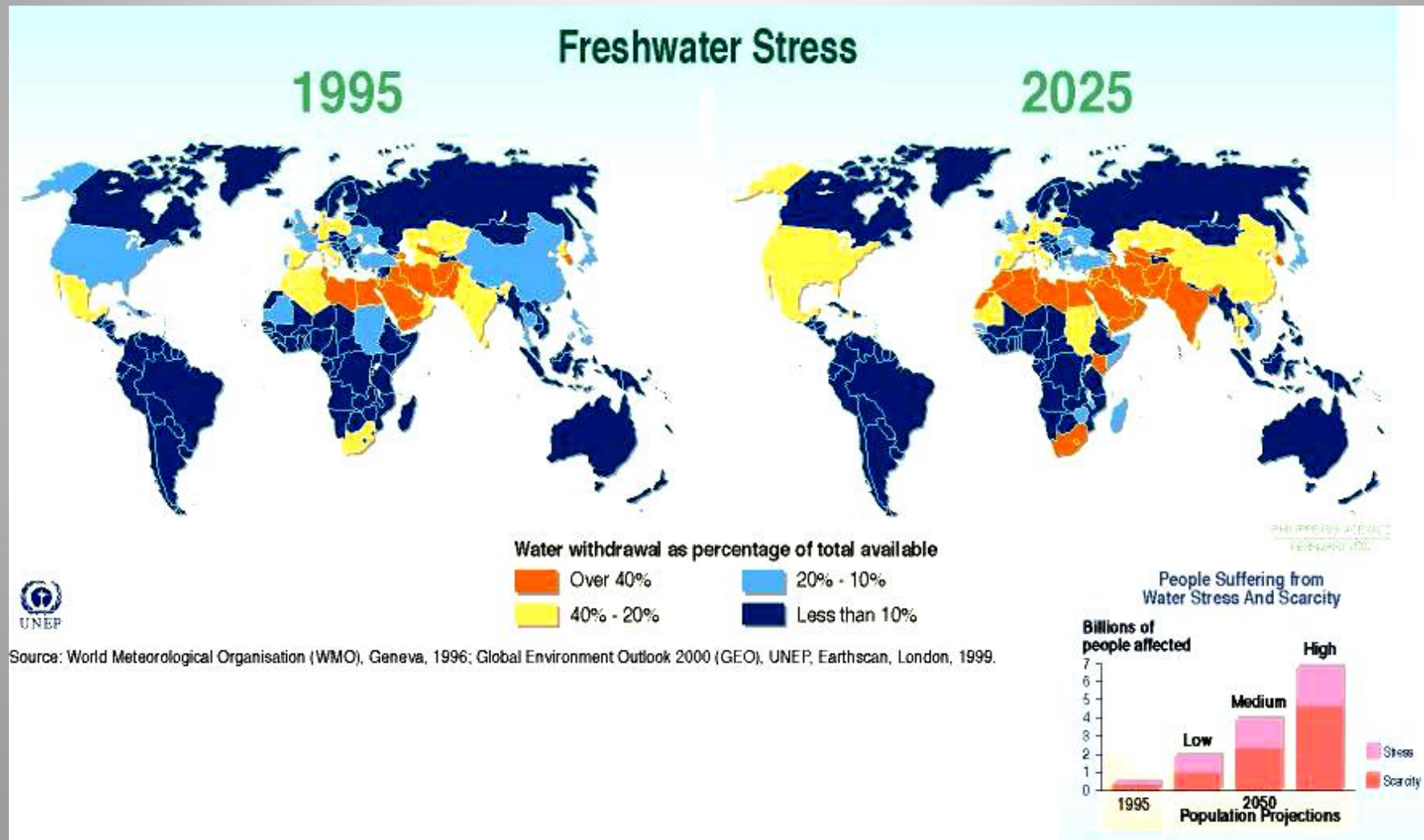


Impacto del cambio climático

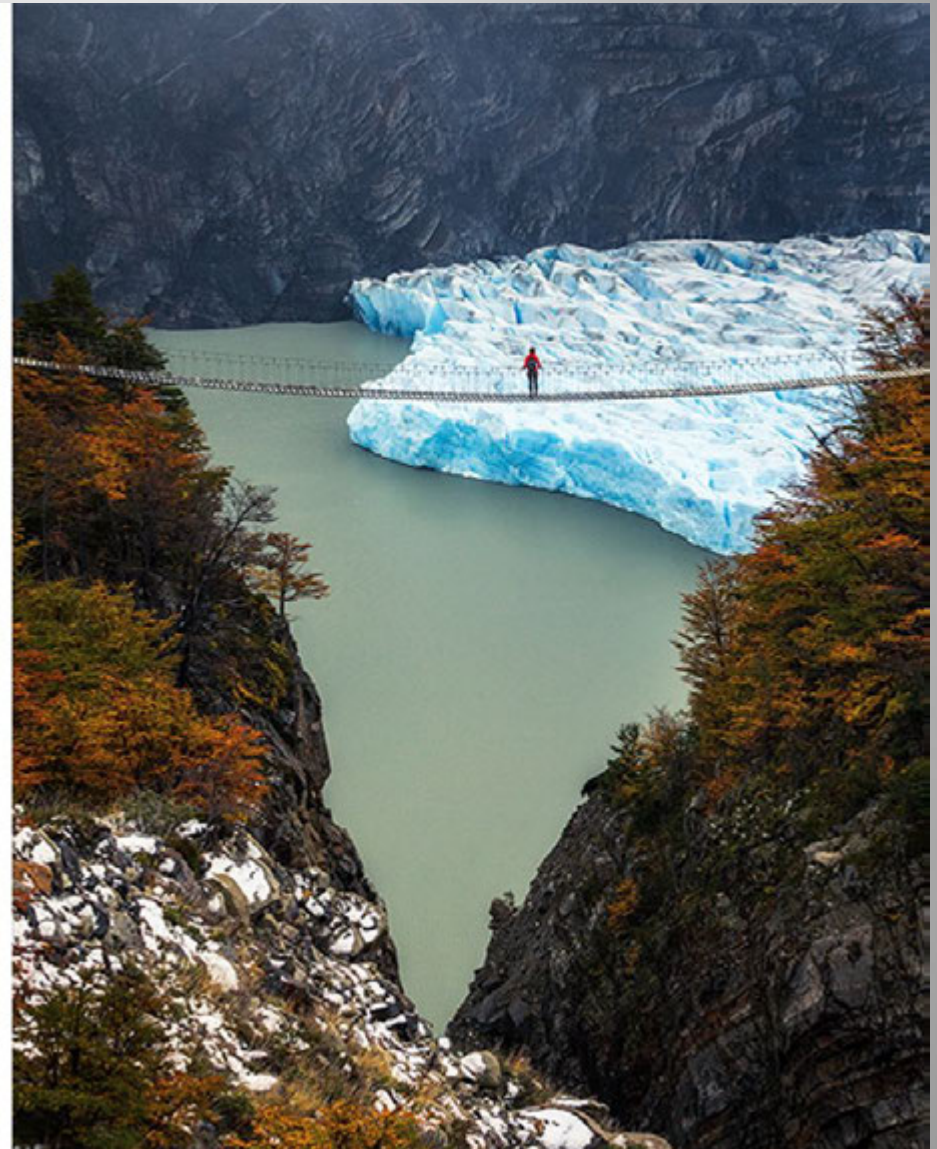
Projected Impacts of Climate Change



En el 2025, los países con escasez de agua aumentará a 48 países con una población combinada de 3 mil millones



Desaparición o retroceso de glaciares



Declaración Mundial KYOTO 2012

Aproved on 5th June 2012 in
Kyoto, by:
International Commission On
Large Dams (ICOLD),
International Commission on
Irrigation and Drainage (ICID),
International Hydropower
Association (IHA),
International Water Resources
Association (IWRA).

World declaration Water Storage for Sustainable Development



In 2050 world population will likely exceed nine billion inhabitants

The global increase in population, both rural and urban, and the socio-economic development with increasing living standards for all, will continuously raise the requirement for water, food and energy consumption. Populations will continue to concentrate in cities where the need for water, food and energy will be most acute. The rapid population growth and socio-economic development means that by 2050:

The continuously increasing demands of water, food and energy will challenge the natural resources. We need to face this exceptional situation because at the same time:

■ Due to climate change, water distribution may become more irregular, and disasters related to floods and droughts will worsen.

■ Energy sources are limited.
■ Fossil energies are polluting and emitting greenhouse gases and their resources are limited.
■ Nuclear energy is restricted to industrial countries which have the technology and the security of nuclear energy has aroused people's wide concern.
■ Variable renewables such as wind and solar sources are valuable and should be developed as much as possible, however, they need back up. Hydropower can play this role, but policies and markets are not encouraging this.

Water is precious and water storage infrastructure will become increasingly important!

Water storage infrastructure, providing multiple water services, is vital for human development. Out of the 40,000 km³ of freshwater available each year, only 3,000 km³ is accessible. Through the construction of more than 50,000 large dams and millions of small reservoirs throughout the world over the past 5,000 years, many communities are able to enjoy reliable water services. These water storage facilities regulate about 4,000 km³ year.

The role of dams and reservoirs in sustainable development has already been acknowledged in various declarations: World Summit on Sustainable Development (2002), Beijing Declaration on Hydropower and Sustainable Development (2004), Dams and Hydropower for African Sustainable Development (2008), and the Millennium Declaration of the Fifth and Sixth World Water Fora (2009/2012).

Humanity is facing a more severe water situation than it has ever faced in the past.

To face this century's greatest challenge - to manage water sustainably - we need to strengthen

existing water systems and further develop new water storage infrastructure. This will require adequate legislation and funding. It must also include the optimisation of the use of water by combining multiple purposes:

- Flood management and drought mitigation
- Irrigation for food production
- Energy production
- Drinking water and sanitation
- Industrial water supply
- Navigation
- Environmental services
- etc.

There is need to improve the maintenance and operation of existing water storage infrastructure.

Taking into account the aging process, improved knowledge, and the effects of climate change, there is a need to increase efforts to maintain the existing water storage infrastructure. For example, modern monitoring and engineering can improve the safety of structures against extreme earthquakes and floods. Climate change is likely to make reservoir regulation more difficult as hydrological patterns change. Reservoir regulation must be optimised to store more floodwater, while considering the requirements of both upstream and downstream areas. With the latest forecasting systems and real-time adaptation of data, dynamic operations to control water levels in reservoirs can achieve the best balance between infrastructure safety and the wise use of water resources.

There is need to accelerate the development of new water storage infrastructure for multiple purposes.

■ **Flood management and drought mitigation**
Floods and droughts are the greatest water management problem for many countries with insufficient water storage infrastructure. Every year, more than 200 million people are affected by flood damage. Due to climate change, floods and droughts will become more frequent and severe. Water storage infrastructure is a key component of water disaster mitigation, especially in developing countries.

■ **Irrigation for food production**
Irrigated agriculture covers about 277 million hectares, about 18% of the world's arable land. This makes this land remarkably more productive, providing about 40% of the world's crop output. Irrigated lands also concentrate agricultural employment, with nearly 30% of the rural population working in these areas. Much of the world's food production must be in regions with long dry seasons. Since arable land area is limited, the

additional production will require efficient use of existing irrigation facilities and extending the area under irrigation through increased water storage facilities. It is estimated that 30% of additional food production by 2023 will need to come from irrigated land.

■ **Energy production**
Hydropower supplies about 16% of the world's electricity today. Hydropower supplies more than 50% of national electricity in about 65 countries, more than 80% in 15 countries, and almost all of the electricity in 13 countries. The flexibility of this renewable resource is fundamental in matching electricity services with demand and contributes to the development of other intermittent sources of electricity production such as solar and wind, which are less flexible. Consequently, the energy stored in water, converted through pure hydropower and pumped storage, improves the reliability of power systems in a clean and efficient manner. Only 30% of the world's identified hydropower potential has been developed. Transforming the undeveloped hydropower potential into ready would save extraordinary amounts of fossil fuel, reduce greenhouse gas emissions substantially and improve the management of water resources.

■ **Drinking water and sanitation**
One in eight people in the world do not have access to safe water for drinking, cooking and sanitation. With the expected population growth, and without investment in storage, the number of people who could not have access to water will reach 4.2 billion by 2023. One of the Millennium Development Goals calls for halving, "by 2015 the proportion of the population without sustainable access to safe drinking water and basic sanitation". Investment in sustainable water storage infrastructure in developing countries would help achieve this goal.

■ **Industrial water supply**
Every manufactured product uses water during its production process. Industrial water use includes purposes such as processing, washing, diluting, cooling, or transporting a product as well as for sanitation needs within the manufacturing facility. Industries that use large amounts of water produce food, paper, clothing, chemicals, refined petroleum, or primary metals, all of which would be developing countries to increase the value of their natural resources. However, sustainable and reliable water supply is a precondition to encourage establishment of such productive industries.

■ **Navigation**
Inland navigation for goods transportation, compared with land and air freight, has many environmental and economic advantages. Inland navigation is also well suited for handling large quantities of cargo and items with large dimensions. For these reasons, nations have encouraged inland navigation on canals and natural river courses. The control of levels in water courses for navigation requires water storage, and this can be an important role for multipurpose reservoirs and infrastructure.

■ **Environmental services**
Water storage infrastructure can keep the healthy life of rivers through ecological operation and serve wider environmental services. They can allow uptake of minimum flows during dry seasons which enable the preservation of many aquatic animals and plants during droughts. Moreover, dams and reservoirs contribute to stabilizing ground water levels in adjacent land areas. Reservoirs can also be used to create new and biologically desirable habitats and to irrigate wetland biomes or wetland forests.

We, therefore, call for joint efforts to develop water storage infrastructure in a sustainable way.

Today, water and energy schemes can be built in a safe, economic, and eco-friendly way. Water, food and energy services are intricately linked and need to be developed in an integrated approach, based on the multi-faceted and cross-boundary nature of water issues in the present world, we call for:

■ Continued cooperation among various stakeholders, government authorities, research institutions, businesses, civil societies, local communities and so on, to speed up the development and implementation of effective and sustainable water solutions.

■ Development of sharing rivers with win-win cooperation to better serve regional requirements on water, food and energy.

■ Improved policies, guidelines and protocols to evaluate and mitigate environmental and social impact of various storage options and to address the concerns of affected communities.

■ Funding agencies to affect action in countries which need water storage, promoting national and regional development, with innovative financing mechanisms.

In conclusion

■ Water is life and water storage infrastructure is an indispensable tool for society.

■ Investment in water storage infrastructure is investment in the green economy.

■ The services they provide will be crucial in the mitigation of, and adaptation to, climate change.

■ To meet growing demands for water, food and energy, it is time to develop solutions for better use of water resources, especially for developing countries, and to match political commitments with action.

■ A balanced approach, combining large, medium and small reservoirs, is required; one that takes into account sustainable development, with full commitment to minimise negative impact.

■ The organisations signing this declaration commit to collaborate with all partners and stakeholders that share this common vision.



Aproved on 5th June 2012 in Kyoto, by:
The International Commission On Large Dams (ICOLD),
The International Commission on Irrigation and Drainage (ICID),
The International Hydropower Association (IHA),
and the International Water Resources Association (IWRA).

La mayor demanda de agua, alimentos y energía impondrán un desafío sobre los recursos naturales

Debido al cambio climático, la distribución de agua
será más irregular,

y

Se agravarán los desastres como inundaciones y sequías

El cambio climático afecta a la regulación de los embalses a medida que la hidrología vaya cambiando

La Operación debe ser optimizada

- Para evitar inundaciones
- Cubrir las demandas aguas abajo

Hay necesidad de desarrollo de nueva infraestructura de almacenamiento de agua.

En conclusión:

- Agua es vida, y los reservorios son una herramienta indispensable.
- Los servicios que las presas proporcionan serán cruciales en la **mitigación del cambio climático**

ICOLD 2019 OTTAWA, CANADA

Declaración mundial sobre Seguridad de Presas

World declaration on Dam Safety



The construction, operation and maintenance of dams and their storage reservoirs have provided significant benefits to humankind throughout history. Storage of water behind dams regulates natural streamflows, provides benefits resulting from increased water availability, renewable energy production and reduction of adverse impacts caused by nature's extremes of flooding and drought. This document addresses the importance of the dam safety, which encompasses water dams, mining tailings dams and levees.

Growing population in our fragile world is causing steady increases in demand for water, food, energy, minerals and flood control. Dams are critical infrastructure to meet these basic human needs as well as rising standards of living. At the same time, however, dams create new hazards involving potential risks to downstream communities, including potential adverse impacts on life, property and the environment. The potential for dam safety incidents, possibly resulting in an uncontrollable or catastrophic release of stored water is of the highest concern.

The profession of dam engineering has a profound ethical responsibility to carry out its professional duties so that dams and reservoirs are designed, constructed and operated in the most effective and sustainable way, while also ensuring that both new and existing dams are safe during their entire lifespans, from construction to decommissioning.

ICOLD and Dam Safety

For almost a century, the International Commission on Large Dams (ICOLD) has made dam safety one of its highest organizational commitments, as stated in the ICOLD Mission statement:

«ICOLD leads the profession in setting standards and establishing guidelines to ensure that dams are built and operated safely, efficiently, economically, and are environmentally sustainable and socially equitable.»

Before the creation of ICOLD in 1918, knowledge on dam safety was disparate, while the need for building water storage infrastructure was very high and growing. It therefore became a priority of ICOLD to disseminate the understanding of the design and operation of dams based on experience within the global dam engineering community. And along with this dissemination came a strong focus on dam safety that has permeated up to the modern era.

ICOLD has played a key role in improving dam safety through its work in collecting and analyzing information on the lessons learned from past successes and failures. Since the very beginning, ICOLD and its thousands of professionals within the member countries have continuously contributed to the improvement of dam safety through publication of technical papers and exchange of experience during Annual Meetings and Congresses. ICOLD's Technical Committees develop Bulletins for publication that summarize the current state of the practice.

Since the creation of ICOLD, the number of failures compared to the total number of

dams in operation has been reduced significantly, which is a positive achievement that reflects the worldwide influence of ICOLD in raising dam design and management standards. Nevertheless, constant vigilance and commitment to dam safety is still required in order to continue the global trend towards safer dams. Any dam incident is a matter of the greatest concern for dam professionals. It is our ICOLD Declaration that Dam Safety is our highest priority.

Changing Conditions of Dam Safety

Due to the vital need for water, food, energy, minerals and flood control, the total number of dams worldwide continues to grow. Maintaining the present trend of a decreasing incidence of dam failure is a never-ending challenge for the profession. ICOLD's role in knowledge transfer and capacity building through the dissemination of the best practices is as pertinent as ever. The science, technology and human roles in dam safety are in constant evolution with many changing conditions:

- Aging of existing infrastructure, creating new concerns related to the integrity of construction materials and equipment, including infilling of reservoirs with sedimentation.
 - Lack of experience in dam safety management and operations in some countries engaged in building dams, requiring the need for capacity building.
 - Retirement of experienced personnel in all countries, leading to a deficiency in qualified engineers trained in dam design.
 - Increasing participation of the private sector in the development of dams as well as increasing unit and time pressure on developers, designers, contractors and operators, creating a need for new governance conditions for dam safety.
 - Climate change causes changes in extreme precipitation and drought events, resulting in increased hydrological risks. It is critical to consider changes in climate during planning and management, including resilient design and adaptive reservoir operation of dams. In some regions, this results in a need to increase the height of dams, expand spillway capacity, modify reservoir operating procedures, and/or construct new dams. There may also be a need to assess and address other hazards created by climate change as part of the planning, design and operational phases.
 - The most suitable sites for dams have largely been utilized, thus new dams must be built in more and more challenging locations, especially regarding geological conditions.
 - Changing local, regional and national governance can have a significant impact in regulatory authority for dams.
- As a recognized international organization of experts in dam engineering, ICOLD calls upon governmental authorities and financing institutions to promote an awareness of the subject of Dam Safety. The goal of this ICOLD World declaration on Dam Safety is to restate the fundamentals of dam

safety that have been learned over time. Furthermore, all involved entities should be reminded to ensure, through the fulfillment of their responsibilities, that these fundamentals are respected in order to minimize risks associated with dams and reservoirs.

Pillars of Dam Safety

With almost a century of commitment to dam safety, and knowing that the zero risk does not exist, ICOLD recognizes several overarching pillars of dam safety:

- **Structural integrity of dams is the keystone to dam safety.** Best current practices of dam design and performance during the occurrence of hazardous events such as extreme floods and earthquakes have been largely documented by ICOLD bulletins in order to create a sound basis on which existing and future dam structures should be designed, built and operated in safe conditions.
- **A routine surveillance and maintenance programme is necessary for early detection.** Inspection and upkeep are of high importance to minimize the risk and to ensure dam safety in the long term. Periodic safety review by qualified engineers that are highly experienced in dam safety assessment is mandatory. Supervision of dams should be based on both the operator's self-supervision and periodic external safety reviews by an independent and competent authority or institution.
- **An instrumentation and monitoring programme is essential throughout the life of a dam.** A comprehensive dam monitoring programme is necessary to: a) determine behavior during construction; b) assess performance during first reservoir filling; c) compare actual performance with design; d) characterize long-term behavior; e) provide early warning of abnormal conditions; f) capture & analyze response to events, such as large floods, earthquakes, etc.; g) predict future performance of dams; and h) demonstrate safe management of the dam to regulatory authorities.
- **Designs intrinsic risks need to be adequately addressed.** These risks are based on dam type, materials, aging, foundations, hydrology, structure, etc., in which good practices and surveillance are the keys for safety.
- **Natural hazard risks change with time, thus should be regularly reviewed and updated.** These hazard risks like floods and earthquakes are external threats, for which risks are recognized based on known science and likelihood of occurrence.
- **Emergency planning is of utmost importance for all dams.** Emergency plans should be developed with the objective of avoiding loss of life and reducing damage to property, infrastructure and the environment resulting from a dam failure. The first filling of the reservoir being a critical period during which the emergency plan must be ready for implementation in a timely manner. Periodic reviews, updates and practice of the emergency plan is mandatory.
- **Adequate training of operators is part of a comprehensive dam safety programme.** Those placed in charge of dams bear an important responsibility to maintain their

training and understanding of their dam. Mis-operation of a dam, especially of spillway gates, can lead to accidents, downstream flooding or potential overtopping of the dam.

• **Sharing lessons learned benefits the entire industry, making all dams safer.** The experience of ICOLD has shown that sharing lessons from dam incidents and failures is crucial to improve state-of-the-art practices. For all involved parties, it is thus imperative that any documentation on dam incidents, including independent expert reports on the root causes of such incidents, be made freely accessible to the international community.

• **A comprehensive dam safety approach will allow minimization of risks.** This is done through collaboration of national organizations to support dam safety structural measures for strengthening the structure's integrity and stability; measures to minimize the consequences of failures as well as education and public awareness about dams. A comprehensive dam safety approach should also consider the fact that river basins, many of which are transboundary basins, often include several dams, or systems of dams and levees.

• **A dam owner has the ultimate responsibility for its dam.** ICOLD recognizes that the safety of all dams is primarily the responsibility and liability of owners and operators. Adequate personnel and financial resources as well as relevant know-how are essential conditions to meet this responsibility.

• **The role of regulatory authorities is paramount for safety.** Regulatory authorities should take a strong role in ensuring adequate site investigation, best practice design standards, quality construction, contractual frameworks, emergency preparedness and operational compliance within accepted guidelines and standards. Developing norms, standards and safeguards is a key factor to proper dam safety surveillance.

• **An international perspective to dam safety can be enlightening.** International organizations such as ICOLD, which provide guidelines based on worldwide experience, can provide important guidance to designers, owners and government authorities to better understand the current state of best practices for design and safety of dams.

Summary Declaration

With the aspirational goal of working towards continuous reduction of dam safety incidents, ICOLD, as the leading international organization committed to dam safety, calls upon all involved professionals and companies to make a firm commitment to safety improvements and risk reductions at all dams.

Furthermore, Governments, Financial Institutions and other Developers, in their contribution to the development and regulation of dam infrastructure, are called upon to make a similar political and financial commitment so that all the important safety recommendations for dams outlined in ICOLD Bulletins, will be disseminated to the relevant entities and followed to completion.

This common effort will contribute immeasurably to the overarching ICOLD vision:



“Better Dams for a Better World”

Approved on October 18th 2019, in Porto.
International Commission On Large Dams

CONDICIONES CAMBIANTES EN LA SEGURIDAD DE PRESAS

- ✓ El cambio climático provoca cambios en las precipitaciones extremas y en los eventos de sequía.
- ✓ En algunas regiones, se requiere:
 - incrementar el volumen de los embalses
 - ampliar la capacidad de los vertederos
 - modificar los procedimientos de operación
 - construir nuevas presas
- ✓ Aumento de los riesgos hidrológicos por lo que es fundamental considerar los cambios climáticos durante la planificación la gestión y diseño resistente

❖ Temas desafiantes

- Vida útil de las presas de embalses y envejecimiento
- Seguridad Hidrológica
- Evaluación de la seguridad
- Adecuación estructural



**¿ Cual es
la vida útil
de una
presa?**



***Presa Santa Genoveva, San Luis
Potosí, 1891***

Presa San Blas, 1755

265 años o más?

¡Hay que tomar el desafío!!

Recálculo de las crecidas de diseño

Rediseño de las obras de Evacuación

¿ Cual es nuestra preocupación?

- ❖ **Se requiere la verificación de las crecidas de diseño.**

En muchos casos las crecidas no han sido calculadas en base a los criterios actuales y al nivel de riesgo que varía con el tiempo

- ❖ **La seguridad hidráulica de las presas antiguas en operación**

En muchas presas antiguas los vertederos no pueden evacuar los caudales actuales o no cumplen los criterios de diseño actuales.

- ❖ **Inexistencia o inadecuados Descargadores de Fondo como órgano de seguridad.**

Consecuencias



ESCABA Tucumán Argentina 2015



LA HUERTITA San Luis Argentina 2015

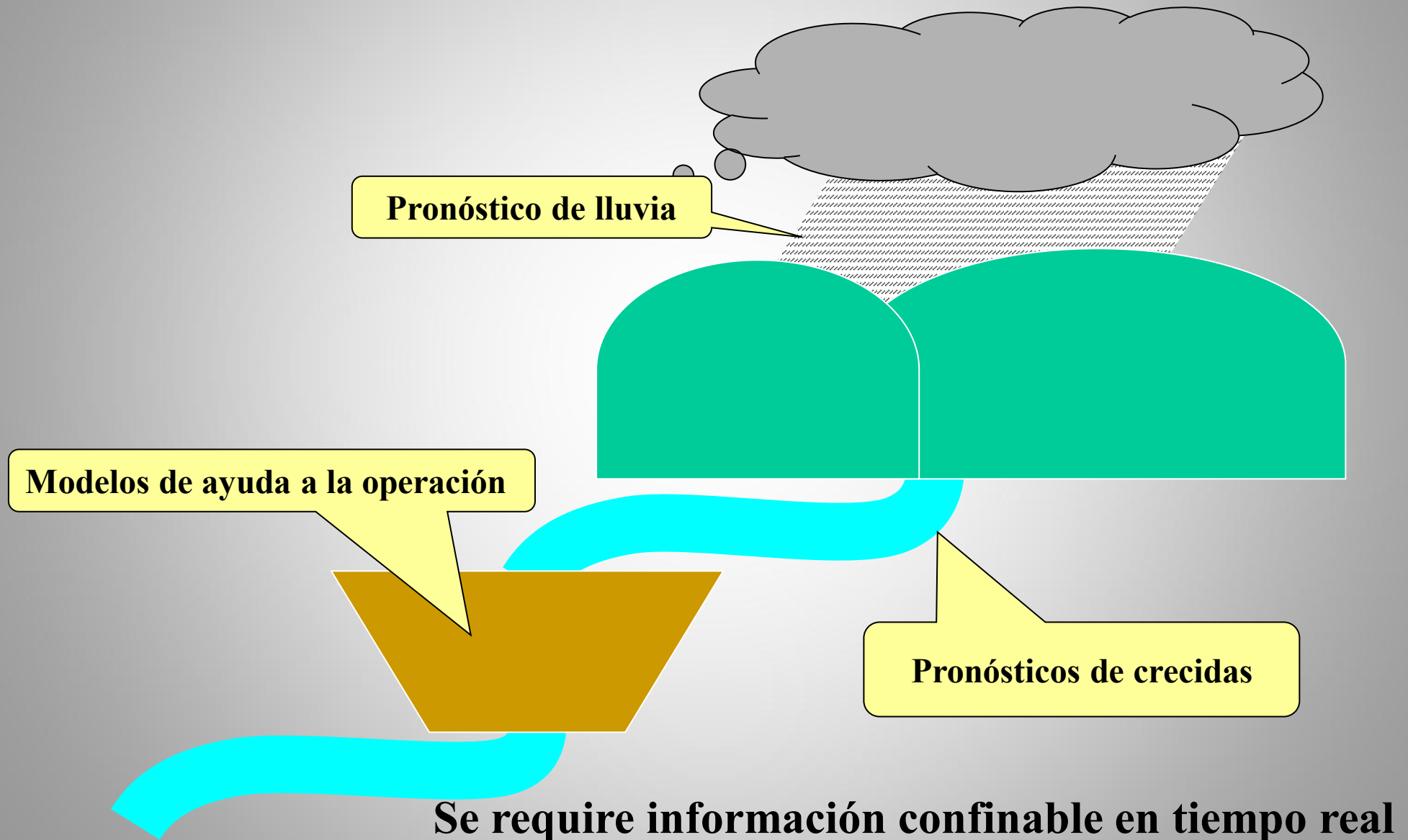
Análisis de la situación

- Cálculo actualizado de la crecida de diseño en función del riesgo (CMP, decamilenaria, otras)
- Bordo libre seguro en condiciones extremas
- Control de volumen útil (topo-batimetrías)
- Colmatación por sedimentación, reducción del volumen de retención de crecidas
- Garantía de provisión de agua
- Invasión de cauces

Agua para consumo Versus Protección contra inundaciones

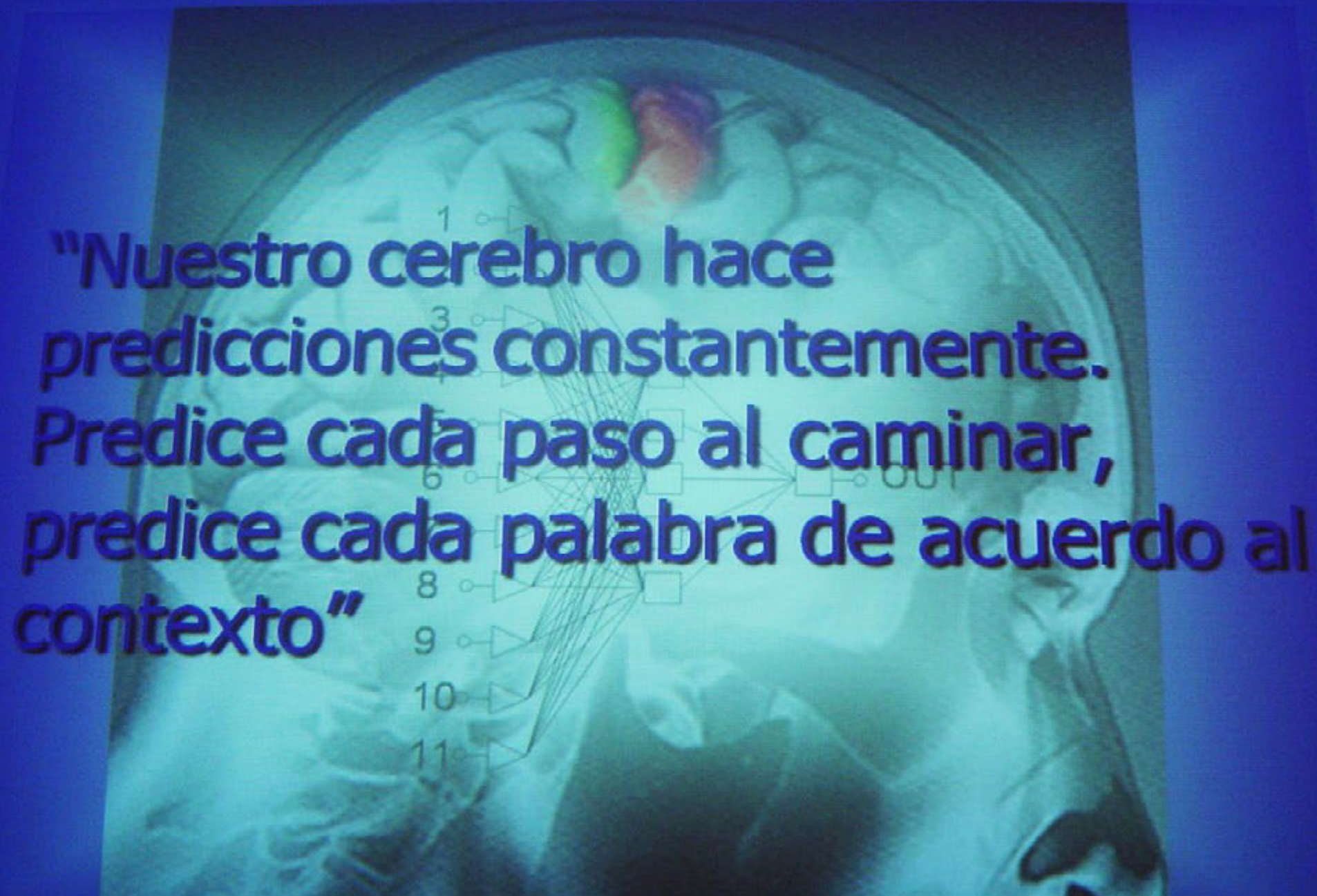


La operación requiere la aplicación de nuevas tecnologías



Acciones en la operación

- Implementación de adquisición de datos en tiempo real
- Operaciones dinámicas para controlar los niveles de agua en los embalses
- Gestión el mejor equilibrio entre la seguridad de la infraestructura y el uso racional de los recursos hídricos.
- Implementar un Sistema de Ayuda a la decisión con Modelos de predicción hidrológico y simulación de embalses (tipo redes neuronales u otros)



"Nuestro cerebro hace predicciones constantemente. Predice cada paso al caminar, predice cada palabra de acuerdo al contexto"

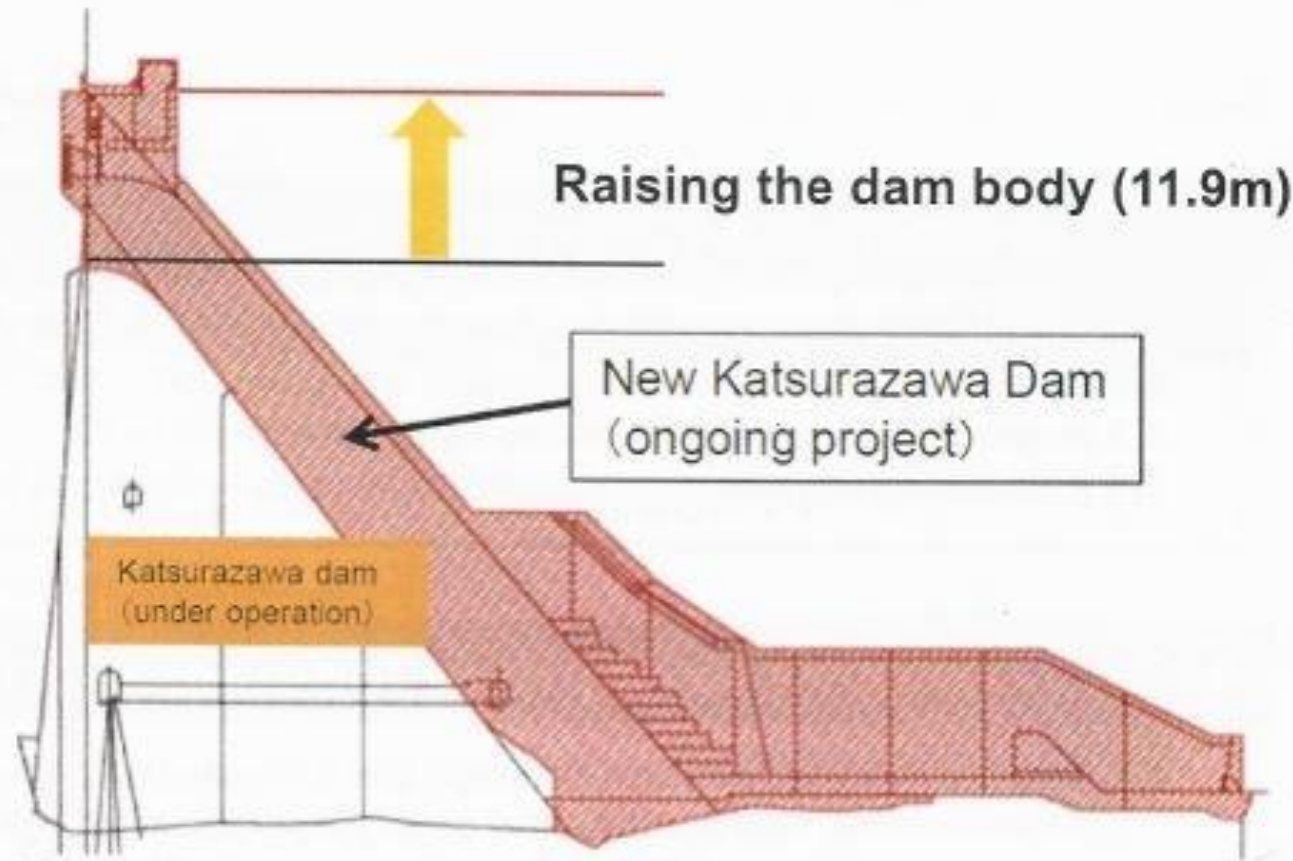
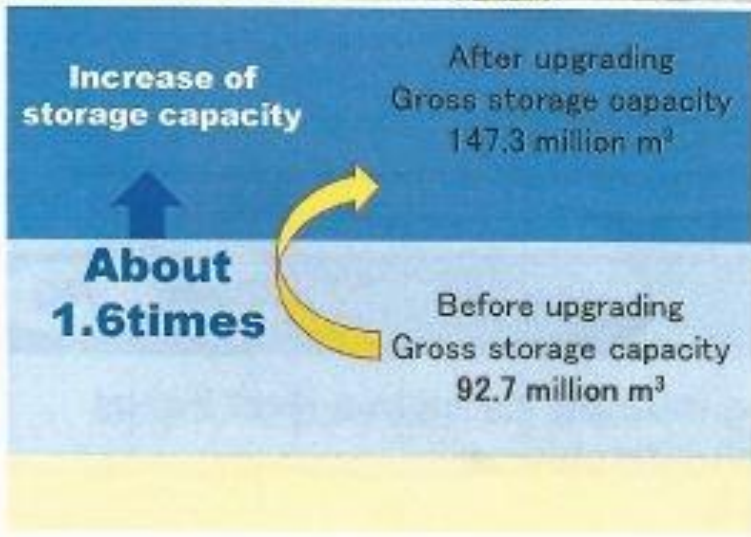
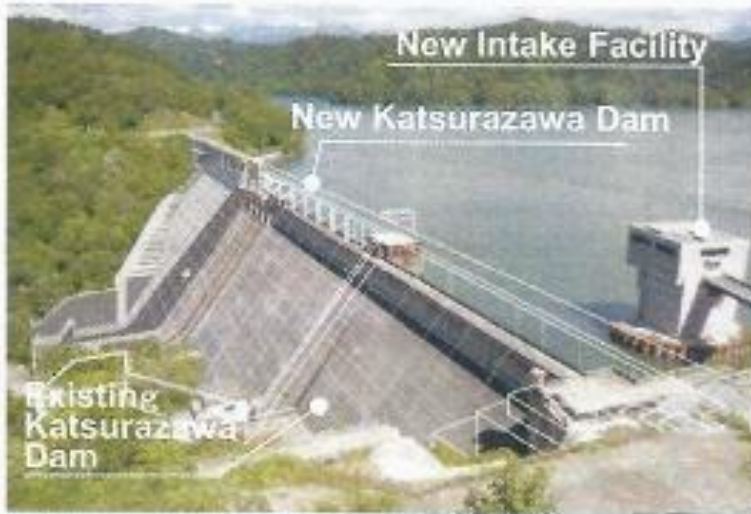
Seguridad hidráulica

- Aumentar la capacidad de los vertederos
- Verificar la capacidad estructural
- Verificación de los equipos de control hidráulicos (compuertas, válvulas, ataguías de mantenimiento, energía)
- Descargadores de fondo adecuados para poder vaciar el embalse en caso de emergencia

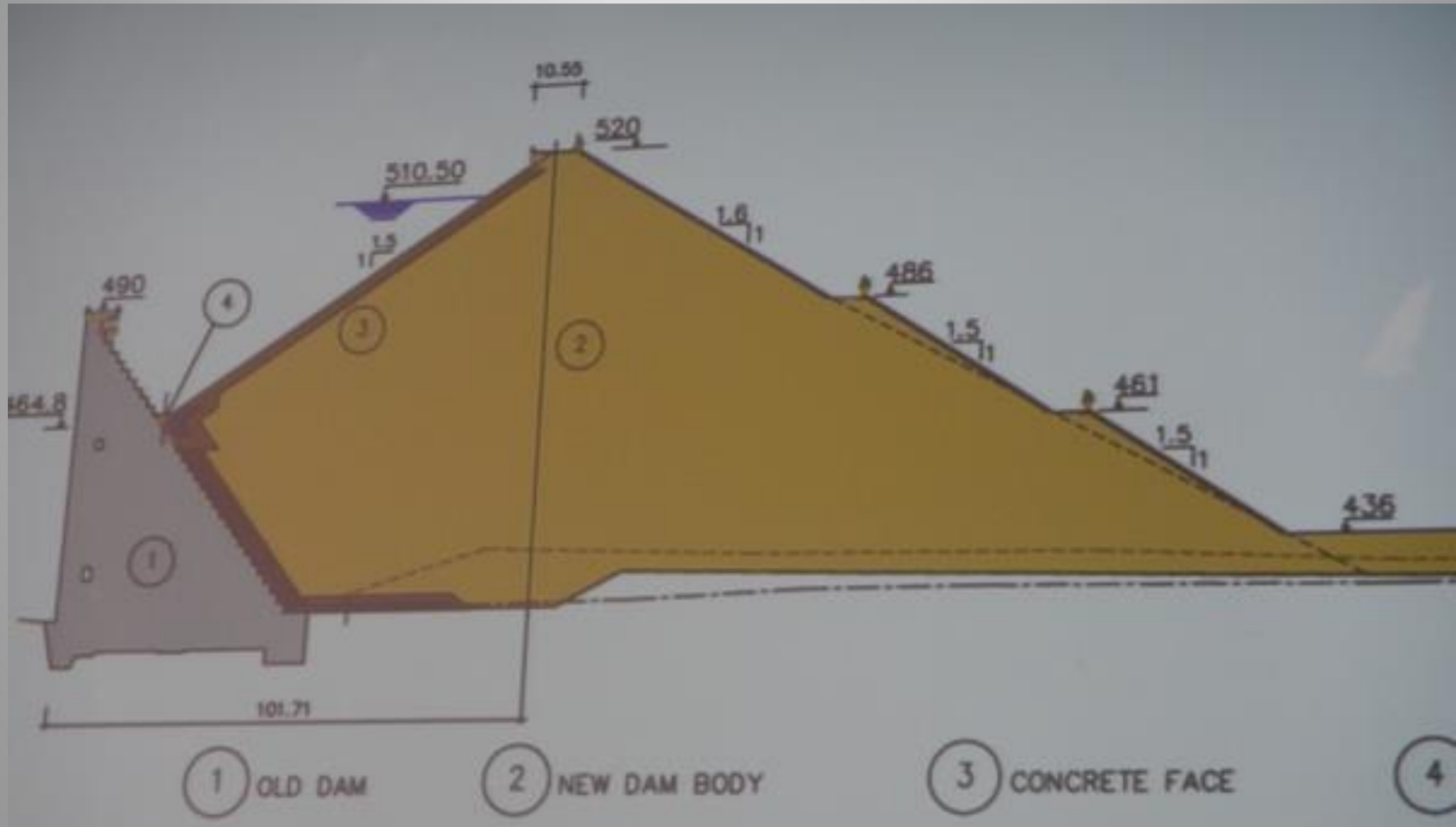
Ampliación de vertederos



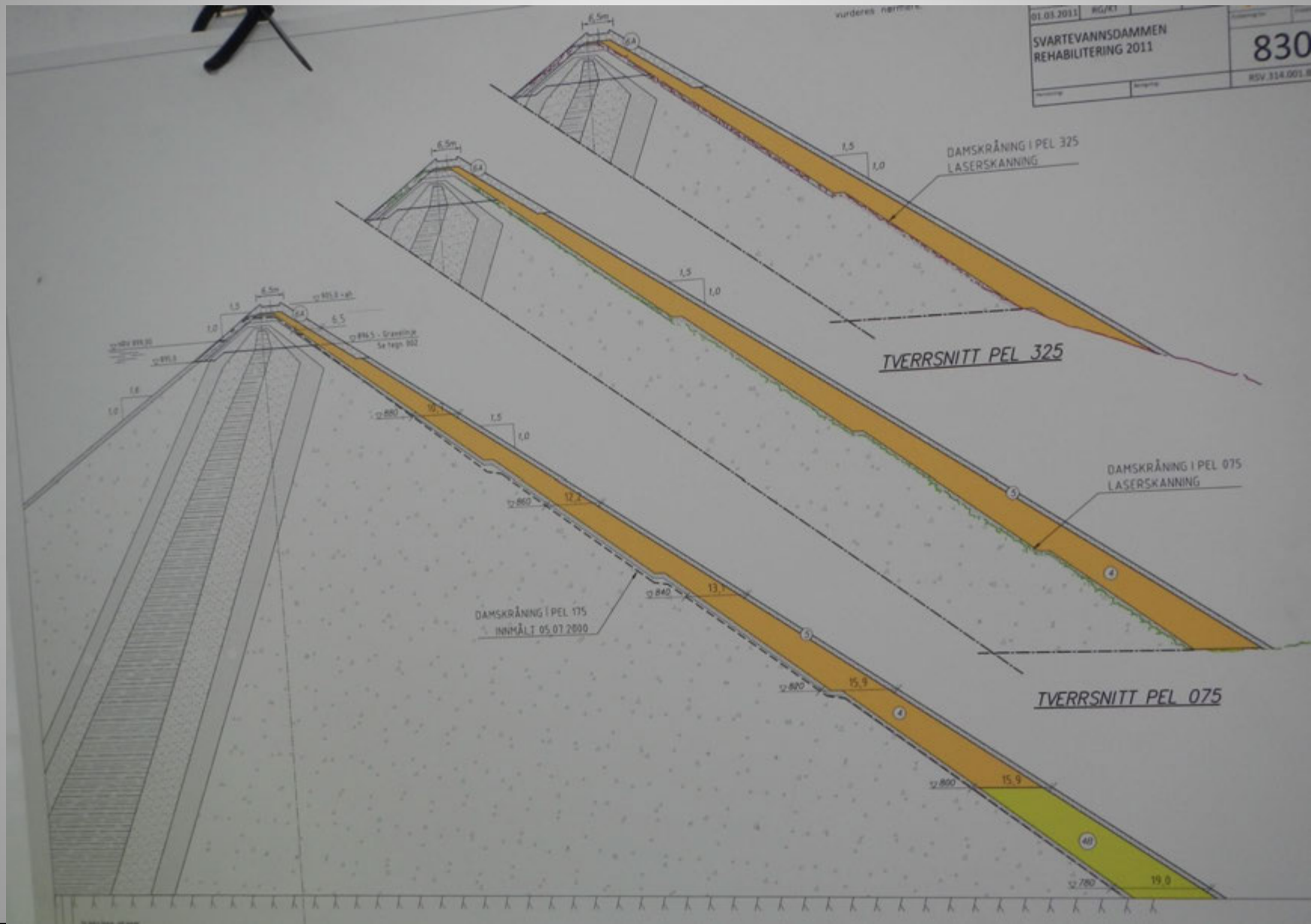
Acciones estructurales –Recrecimientos



Acciones estructurales – Recrecimientos



Refuerzos estructurales





Vigilancia

- Inspección técnica especializada de las estructuras de descarga (en 3 niveles).
- Realizar ensayos sistemáticos de los órganos de evacuación (compuertas, válvulas, ataguías de mantenimiento, energía)
- Realizar los mantenimientos necesarios

OROVILLE - USA

Febrero 2017







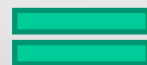
OROVILLE- USA

PLAN DE ACCION DURANTE EMERGENCIAS

IMPOSIBILIDAD DE ELIMINAR COMPLETAMENTE LA PROBABILIDAD DE ROTURA O FALLA



**POSIBILIDAD QUE ESTAS FALLAS TENGAN COMO
CONSECUENCIA DAÑOS DE MAGNITUD CONSIDERABLE**



**PREVER QUE ACCIONES DEBEN LLEVARSE A CABO PARA REDUCIR EL
RIESGO Y PARA HACER FRENTE A CADA UNA DE LAS FALLAS
POSIBLES**

Reflexión

ES MEJOR ESTAR PREPARADOS PARA ALGO
QUE NO VA A SUCEDER,

A QUE NOS SUCEDA ALGO
PARA LO CUAL NO ESTAMOS PREPARADOS!!

PLAN DE ACCION DURANTE EMERGENCIAS

Los objetivos son:

- ✓ Salvaguardar la vida de los habitantes aguas abajo de la presa de embalse.
- ✓ Mitigar los daños de las propiedades y del medio ambiente aguas abajo.

Deben mantenerse actualizados y ensayados con la población en riesgo



Muchas Gracias

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