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DAMS SECTOR

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In this month's issue of *The CIP Report,* we feature the Dams Sector. The Dams Sector includes dam projects, navigation locks, levees, hurricane barriers, mine tailings and other industrial waste impoundments, water retention and water control facilities, and hydropower plants. We take a look at these different aspects of the Sector throughout this issue.

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First, the Executive Director of the Association of State Dam Safety Officials (ASDSO), a key partner in the Dams Sector, discusses their efforts to protect dams and their associated elements in the United States. Another key partner in the Dams Sector, the U.S. Army Corps of Engineers (USACE), discusses the importance of public-private partnerships in leading security and protection efforts for dams. Then, the dams and reservoir markets in the United States are examined by a Design Manager at ASI Constructors, Inc. A representative from International Rivers describes some of the safety and security concerns for international dams, focusing on earthquakes, food and regional security, and climate change. Next, the General Manager Infrastructure at Goulburn-Murray Water in the State of Victoria, Australia highlights the role that risk assessments play in dam safety programs. The Executive Director of the International Hydropower Association examines sustainable hydropower, specifically the recently developed tool, *Hydropower Sustainability Assessment Protocol*. Finally, an academic researcher and consultant on water law and policy expounds upon the challenges and opportunities pertaining to the Grand Ethiopian Renaissance Dam, a new dam being constructed in Ethiopia that will impact numerous countries in Africa.

This month's *Legal Insights* briefly reviews the legal challenges associated with the 2011 Mississippi River flooding and the subsequent opening of the Morganza Spillway.

We would like to take this opportunity to thank the contributors of this month's issue. We truly appreciate your valuable insight.

We hope you enjoy this issue of *The CIP Report* and find it useful and informative. Thank you for your support and feedback.

Mick Kicklighter
Director, CIP/HS
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Public-Private Collaboration Brings Ongoing Success to the Dams Sector

by Lori C. Spragens, Executive Director, Association of State Dam Safety Officials

One of the 18 critical infrastructure sectors identified through Homeland Security Presidential Directive (HSPD) 7 is the Dams Sector. In a few short years, the Dams Sector — capitalizing on its public-private partnership model — has created a variety of Nation-wide and regional programs along with a vast range of products, research, resources, training, and information sharing tools. A key partner is the Association of State Dam Safety Officials (ASDSO). ASDSO's role within the Dams Sector is to coordinate the participation of State subject-matter experts, representing the dam regulating community; provide technical resources and data; and, support the dissemination of training materials and information for the Sector.

The Dams Sector comprises dam projects, hydropower plants, navigation locks, levees, dikes, hurricane barriers, mine tailings and industrial waste impoundments, and other similar water retention and water control facilities. These assets represent a vital and beneficial part of the Unites States' infrastructure and continuously provide a wide range of economic, environmental, and social benefits, including hydroelectric power, river navigation, water supply, wildlife habitat, waste management, flood control, and recreation. However, the potential risks associated with Dams Sector asset failure, regardless of causation, are considerable and could result in significant destruction, including loss of life, massive property damage, and severe long-term consequences.

The Office of Infrastructure Protection (IP) within the National Protection and Programs Directorate of the U.S. Department of Homeland Security (DHS) serves as the Sector Specific Agency (SSA) for the Dams Sector. The Dams SSA directly coordinates national protection and risk mitigation activities through ongoing collaboration with the Dams Sector Coordinating Council (DSCC) and the Dams Sector Government Coordinating Council (DGCC). These councils provide the primary vehicle through which representatives from the government (Federal, State, and local) and the private sector can effectively collaborate and share approaches focused on the improvement of critical infrastructure protection.

Resources developed by the Dams Sector provide a wealth of useful information ranging (but not limited) from: active and passive vehicle barriers, water side barriers, personnel screening procedures, security awareness for dams and levees, protective measures, emergency preparedness, as well as cybersecurity and the importance of control systems.

The Sector has implemented a series of free web-based training courses, with accompanying guidance documents, which cover a multitude of issues regarding security awareness, protective measures, and crisis management. These courses are offered through the Federal Emergency Management Agency (FEMA) Emergency Management Institute (EMI) and users are provided with a corresponding certificate of completion. These courses include:

- *Independent Study (IS)-872 Dams Sector: Protective Measures* addresses protective measures related to physical, cyber, and human elements, and emphasizes the importance of these measures as components of an overall risk management program. It also describes the basic elements of risk management, discusses the steps required to develop and implement an effective protective program, and helps stakeholders develop protective programs based on a systematic assessment of threats, selected levels of protection, and consideration of constraints.

- *IS-871 Dams Sector: Security Awareness* provides information to enhance the ability to identify

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security concerns, coordinate proper response, and establish effective partnerships with local law enforcement and first responder communities.

• *IS-870 Dams Sector: Crisis Management* addresses crisis management activities as an important component of an overall risk management program and provides dam and levee stakeholders with recommendations to assist in the development of various plans focused on enhancing preparedness, protection, recovery, and resilience capabilities.

The IS-871 and 872 courses are designated as "For Official Use Only" and are available only through the Homeland Security Information Network-Critical Sectors (HSIN-CS) Dams Portal. IS-870 is available to the public on the FEMA EMI website.

In the works for future training through a collaborative effort between the Dams SSA and ASDSO are two new reference documents: *Estimating Loss of Life for Dam Failure Scenarios* and *Estimating Economic Consequences for Dam Failure Scenarios*. These companion guidelines offer recommendations for the assessment of direct loss-of-life and fatality rates and the evaluation of direct and indirect economic impacts resulting from worst reasonable case scenarios. The goal is to create classroom and eventually self-paced training on estimating consequences from dam failure with a special focus on these reference documents.

The Dams SSA and ASDSO are also collaborating with sector partners to develop the Dam Security and Protection Technical Seminar. This seminar aims to provide owners, operators, State dam safety regulators, and other related stakeholders with a comprehensive "101" overview of dam security, protection, and crisis management-related issues. The first presentation of this seminar will be in 2012.

As important as the training partnership is to ASDSO and the Sector, information sharing is assigned equal billing. One way to efficiently share the multitude of aforementioned sector reference materials is through presentations at national and regional conferences, like those held by ASDSO, the U.S. Society on Dams, or the National Hydropower Association. Even better is the idea of creating a national event dedicated to the Dams Sector. In support of this idea, the Dams SSA and ASDSO began conducting the Annual National Dam Security Forum in conjunction with ASDSO's Annual Dam Safety Conference. Started in 2008, this forum is the premiere national summit where public and private stakeholders can get the latest information regarding dam security, protection, and resilience.

This year, ASDSO and DHS held the Fourth Annual National Dam Security Forum in conjunction with ASDSO Dam Safety '11 from September 25-29 at the Gaylord National Resort Hotel and Convention Center in National Harbor, MD. This year's forum featured a variety of presentations, ranging from security considerations to emergency preparedness efforts.

During this conference and throughout the year, ASDSO assists the Dams Sector in publicizing other useful tools that enhance information sharing. Here are some examples:

• The on-line Dams Sector Suspicious Activity Reporting (SAR) tool provides stakeholders with the ability to horizontally report and retrieve information pertaining to suspicious activities. The SAR tool is available via the HSIN-CS Dams Portal and offers vetted sector partners the opportunity to better understand the implications of incidents that occur throughout the Nation. Once a report is entered via the SAR tool, automatic notifications are sent within 30 minutes to a predetermined list of sector stakeholders informing them that a suspicious activity has been reported. As such, vetted partners are able to examine reports from a broad range of sector stakeholders and subsequently determine the need to implement protective measures.

The Dams Sector Tabletop Exercise Toolbox (DSTET), developed by the Dams SSA in coordination with sector partners, directly assists stakeholders in planning and conducting security-based tabletop exercises in accordance with the Homeland Security Exercise and Evaluation

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The Importance of Public-Private Partnerships in Leading Security and Protection Efforts for Dams

by Yazmin Seda-Sanabria[1] and Robert B. Stephan[2]

Introduction

As evidenced by recent events around the world, such as the extensive wildfires in the Southeast and Southwest regions of the United States, historical floods of the Mississippi and Missouri Rivers, the Eastern Japan tsunami and Fukushima nuclear disaster, and the terrorist attacks in Norway, the global risk environment is highly unpredictable and unforgiving. These disasters have demonstrated that their impact can be often catastrophic, reaching vastly populated areas and potentially hindering the critical infrastructures that underpin their local communities. Our critical infrastructure and those who operate them face an ever growing array of natural and manmade threats that may include earthquakes, floods, hurricanes, tsunamis, domestic and international terrorism, pandemic influenza, aging, environmental degradation, industrial accidents, wildfires, and cyber intrusion, among others. Each of these threat actors is capable of producing significant consequences depending on the location of the infrastructure, its inherent vulnerabilities, proximity of local population centers, number of people served, and interdependencies with other critical systems. Critical infrastructure vulnerabilities manifest themselves both within and across other infrastructure sectors as a function of complex physical, cyber, and human challenges, and if exploited, they can severely impact "just-in-time" operations that are tied to the global economy and international supply chains. To address these various challenges, the *National Security Strategy* calls for a comprehensive approach that improves the resilience of our Nation's infrastructure through risk-informed prevention, protection, and preparedness programs that are specifically designed to reduce the most serious risks to the American people and our economy.

When considering the protection and resilience of our critical infrastructure, we must acknowledge the fact that the responsibility and accountability for such matters are distributed across a wide spectrum of government and industry stakeholders at all levels as well as a multiplicity of agencies and security, emergency management, and public safety disciplines. Protection and resilience strategies must be tailored according to diffuse risk environments, operating landscapes, stakeholder authorities, and capacities. Security and resilience are better assured when they are "built in" rather than "bolted on." A key element to the success of this approach relies on the development of sustainable public-private partnerships to enhance planning and multi-jurisdictional coordination in the context of a wide range of potential threats and hazards.

The National Infrastructure Protection Plan (NIPP) provides the unifying partnership structure for the integration of critical infrastructure protection and resilience as part of a coordinated national program. This plan, its supporting sector plans, and the public and private sector partnership they represent are at the core of our Nation's all-hazards approach to homeland security preparedness and domestic incident management. Within the context of the NIPP, the Dams Sector comprises dam projects, navigation locks, levees, hurricane barriers, mine tailings impoundments, and other similar water retention and/or control facilities. There are over 82,000 dams in the United States; approximately 65 percent are privately owned and more than 85 percent are regulated by State Dam Safety Offices (see previous article

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for information on ASDSO).

Over the past decade, the Dams Sector has made significant progress in developing a comprehensive risk assessment and management framework to enhance the protection and resilience of critical assets under its purview. This progress comes as a direct result of a robust and dynamic public-private partnership within this sector that has driven a number of successful activities and initiatives focused on critical infrastructure identification and prioritization; security risk assessment and management; information sharing mechanisms; and research and development initiatives for blast mitigation. This article provides an overview of some of the Sector initiatives in each of these areas, and the progress made since the tragic events of 9/11.

Dams Sector Partnership Model

The public-private partnership is the mechanism championed by the NIPP to promote and facilitate sector and cross-sector planning, coordination, collaboration, and information sharing of critical infrastructure protection and resilience activities between the public sector (Federal, State, local, and tribal governments) and the private sector. The Dams Sector operates under the Critical Infrastructure Partnership Advisory Council (CIPAC) framework, which facilitates effective coordination between Federal infrastructure protection programs and infrastructure protection activities of State, local, tribal, and territorial governments, and the private sector. CIPAC provides a forum that allows government and private sector partners to engage in a broad spectrum of activities to support and coordinate critical infrastructure protection. The CIPAC framework consists of a Sector Coordinating Council (SCC) and Government Coordinating Council (GCC). The goal of this enterprise framework is to establish the context and provide specific support for the activities required to implement and sustain national- and sector-level critical infrastructure protection and resilience efforts. As such, the sector has adopted a vibrant and dynamic public-private partnership approach to promote and enable risk assessment, risk management, planning, training and exercises, and other core activities. The Dams Sector and Levee Sub-Sector GCCs and SCCs include representation from dozens of Federal, State, and local government agencies, private sector owners, and other non-governmental organizations. These forums enable direct collaboration, dialogue, and program development and implementation across the spectrum of Sector stakeholders.

U.S. Army Corps of Engineers Critical Infrastructure Protection and Resilience Programs

The U.S. Army Corps of Engineers (USACE) is a key leader and stakeholder in the implementation of this national approach within the Dams Sector, as an owner and operator of a large portfolio of water resource facilities that provide multiple functions in support of its Civil Works mission and the Nation. Within the Corps, the Critical Infrastructure Protection and Resilience (CIPR) program leads the implementation of this national strategy. Its vision is to achieve a more secure and more resilient Civil Works critical infrastructure portfolio in order to prevent, deter, or mitigate the effects of manmade incidents and improve response and rapid recovery in the event of an attack, natural disaster, and other emergencies affecting Sector assets. The CIPR program supports the NIPP and the National Response Framework, and it is directly aligned with the Dams Sector-Specific Plan. The objectives of the CIPR program include assessing and prioritizing Corps Civil Works critical infrastructure by implementing a portfolio-wide risk assessment framework through the integration of both system-level and asset-specific activities. This approach has enabled a more effective and efficient management of security risks to USACE Civil Works critical infrastructure, and is contributing to manage security risks and guide life-cycle investments collaboratively with other partners across the Sector.

Identification and Prioritization of Critical Infrastructure

Considering the large number of assets within the Dams Sector, a clear and consistent strategy was needed to identify the subset of those high-consequence facilities whose failure or disruption could potentially lead to the most severe impacts, and to conduct a

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Partnerships *(Cont. from 5)*

systematic sector-wide prioritization. The Consequence-Based Top Screen (CTS) methodology was jointly developed by the Dams GCC and SCC, under the auspices of the CIPAC framework. The CTS methodology can be used to identify critical facilities within a portfolio (i.e., those high-consequence facilities whose failure or disruption could be potentially associated with the highest possible impact among portfolio assets). By focusing on potential consequences and decoupling the analysis from the threat and vulnerability components of the risk process, the CTS approach serves as an effective all-hazards preliminary prioritization scheme. In the case of human threats represented by an intelligent and adaptive adversary, it would be practically impossible to conduct in-depth vulnerability evaluations of all assets in a target-rich environment such as the Dams Sector and portfolios within it (i.e., USACE). In this case, the CTS approach can effectively reduce the size of the problem by identifying those assets that could potentially attract higher adversarial interest.

The CTS is supported by a user-friendly, web-based tool which allows users to consider different consequence categories: human impacts, economic impacts, and mission disruption impacts. In 2009, the CTS methodology was adopted by USACE and is being implemented by the CIPR program to screen and identify its critical facilities (dams and navigation locks) through a national cadre. This consistent process provides valuable information to USACE and at the same time enables comparison of high-consequence facilities across the portfolio. The prioritization information obtained from the CTS process is used to support decisions regarding the need for additional analyses and detailed studies. For example, as an owner responsible for a large portfolio of dams, those facilities identified as high-consequence assets through the CTS process are assigned a higher priority within USACE for conducting detailed risk assessments. The results from the CTS process could also effectively inform decision-makers about facilities within a specific area that should receive particular attention from the emergency management community because of their potential for significant impacts at the local and regional levels.

A Portfolio Approach for Security Risk Assessment

In 2006, USACE initiated a comparative risk assessment methodology study for civil infrastructure projects with the goal of evaluating the effectiveness of existing assessment practices in addressing infrastructure security risk. Further interagency collaboration between USACE and DHS expanded upon the results provided through this initial effort and broadened its focus to the sector enterprise level. None of the existing models studied satisfied the need for a practical approach suitable for comprehensive sector-wide application nor could they provide analytically-based results and enable the objective comparison of the various asset types within the Dams Sector portfolio. Nevertheless, this initial collaborative effort helped establish and define in detail the requirement for a portfolio-wide risk assessment framework utilizing a simple, yet mathematically defensible and scalable model to support rigorous sector-level risk analysis and prioritization.

To fulfill this requirement, the USACE CIPR program and DHS Dams SSA are collaborating to develop and implement the Common Risk Model for Dams (CRM-D), a security risk assessment methodology intended to serve as the basis for portfolio-wide risk assessment of critical dams and navigation locks. The CRM-D methodology incorporates commonly known risk metrics that are transparent, easy-to-use, and mathematically rigorous. CRM-D takes into account the unique features of dams and navigation locks and provides a systematic approach for evaluating and comparing risks to terrorist threats. Through application of the methodology, risk is identified as a function of plausible attack scenarios, probability of a successful attack, and predictable consequences in terms of human health and safety and economic impacts. In 2011, the CRM-D methodology is being piloted at a representative number of critical projects in the USACE Northwestern Division (Columbia River, Willamette River Tributary, and Missouri River basins), Mississippi Valley Division

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Partnerships *(Cont. from 6)*

(Mississippi River basin), and Great Lakes and Ohio River Division (Ohio River basin).

Information Sharing

The Dams Sector uses multiple mechanisms and systems to support all-hazards information sharing requirements as developed by Sector partners. The Dams Sector Suspicious Activity Reporting Tool and the DHS Executive Notification Service (ENS) are used, respectively, to alert vetted Dams Sector stakeholders of suspicious incidents and trends and convey urgent alerts and notifications pertaining to emergent threats and all-hazards incidents to Sector leadership across government and the private sector. Other information sharing requirements are supported through periodic classified briefings to Sector leadership and the robust Sector information sharing enterprise platform, the HSIN-CS Dams Portal. The utilization of the HSIN-CS Portal continues to expand within the Sector, and a comprehensive peer vetting process has been developed to allow controlled stakeholder access to "For Official Use Only" materials contained in the portal.

Regional Resilience Efforts

The Dams Sector Exercise Series (DSES) program is as a collaborative process led by USACE and DHS, with the purpose to identify, analyze, assess, and enhance regional preparedness and disaster resilience, using multi-jurisdictional discussion-based activities involving a wide array of public and private stakeholders. For a given region, a particular scenario serves as the triggering event to analyze impacts, disruptions, critical interdependencies, and stakeholder roles and responsibilities. The discussion-based process is executed under the framework provided by the Homeland Security Exercise and Evaluation Program (HSEEP), maintained by FEMA. This framework provides a standardized methodology and terminology for activity design, development, conduct, evaluation, and improvement planning, and can be adapted to a variety of scenarios and events (from natural disasters to terrorist incidents). To date, three major regional efforts involving multiple dams and levee systems, cascading impacts, and critical infrastructure interdependencies have been conducted as part of the DSES program: Bagnell/Truman Dams (DSES-08), Columbia River Basin (DSES-09), and Green River Valley (DSES-10).

Research and Development Efforts for Blast Mitigation of Dams

The Dams Sector is committed to developing a thorough understanding of the effects that potential attacks could have on its assets and the far reaching impacts on other sectors of the Nation's infrastructure, and identifying opportunities to minimize the likelihood of their occurrence or minimize their impacts. A key Sector priority includes refining the current understanding of the effects of potential attacks, vulnerabilities and weaknesses of its critical assets, and local and regional consequences of those attacks in order to develop appropriate protective measures and recovery technologies. One of the key requirements for both the assessment of risks and mitigation of blast damage to dams from terrorist threats focuses on the development of blast damage estimation tools to support the assessment of critical components on dams, locks, and levees as part of the overall risk evaluation process. In 2007, USACE and DHS established an interagency agreement initiating a collaborative R&D program to address technical gaps related to risk and blast mitigation for dams. Their ensuing efforts have involved experimental and analytical activities designed to improve blast damage prediction capabilities for dams, navigation locks, and levees resulting from vehicle and waterborne attacks. The outcomes of these efforts are being incorporated into the improvement of a blast damage prediction tool that can be utilized by dam owners and operators to assess the vulnerabilities to various threat conditions and facilitate the implementation of effective protective measures at these critical facilities.

Conclusion

The Dams Sector has come a long way in the last decade in better assessing and managing risk of its critical infrastructure in a very dynamic global risk environment. These collaborative efforts have been effective in leveraging

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The Relative Health of the Dams and Reservoirs Market

by Del A. Shannon, PE[1]

Introduction

Dams and reservoirs have been a part of our society for hundreds of years. In the United States alone, there are approximately 85,000 dams that serve dozens of purposes — from power generation to flood control to mine tailings containment to water supply. Yet, with these structures serving as such integral systems in every aspect of our lives, little about their financial influence is understood or openly discussed. Current discussions surrounding the dams and reservoirs, and more recently levees, market is limited to individual projects, specific owners such as the Bureau of Reclamation and U.S. Army Corps of Engineers, or included in a general discussion surrounding the aging infrastructure in the United States.

Since 1998, the *Engineering News Record (ENR) Magazine* has been compiling and reporting firm revenues for specific market sectors, and using this data to rank firms by market sector. This includes the dams and reservoirs market sector, where the top 10 firms are annually ranked. As a first attempt to gauge the relative health of the dams and reservoirs market, the combined revenues of these 10 firms for each year reported were compiled. Data was first reported in 1998 when the combined revenue of the top 10 dam firms was $97.1 million. In July 2010, the combined revenues of the top 10 dam firms were $753.1 million. This equals an average annual market increase of 20 percent and is an exceptional growth rate when compared to other markets and industries. The revenues of the top 10 dam and reservoir firms have, as a whole, been growing at a rate 3 ½ times faster than the growth rate of the combined revenues of the top 500 design firms, as reported by the ENR. Figure 1 provides a graph of these data.

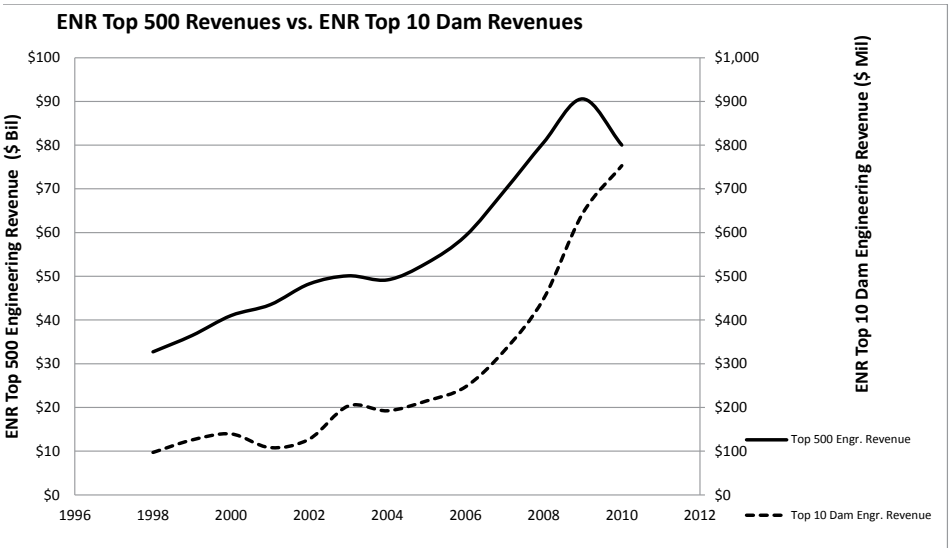

Figure 1: ENR Top 500 and Top 10 Dams and Reservoirs Engineering Revenues – 1998 to 2010.

U.S. Bureau of Economic Analysis

Another source of information considered when evaluating the dam and reservoir market was gross domestic product (GDP) data, obtained from the U.S. Bureau of Economic Analysis (BEA) website. The BEA compiles individual GDP data from thousands of industries and uses this to determine the combined GDP of the United States. From 1977 to 1997, this included GDP on a category titled "New Dams and Reservoirs." Annual GDP for "New Dams and Reservoirs" from the BEA website produced Figure 2 (see Page 9).

GDP numbers for new dams and reservoirs are inclusive of construction costs. To estimate engineering revenues, it was assumed that engineering is typically 10 perecent of any heavy

(Continued on Page 9)

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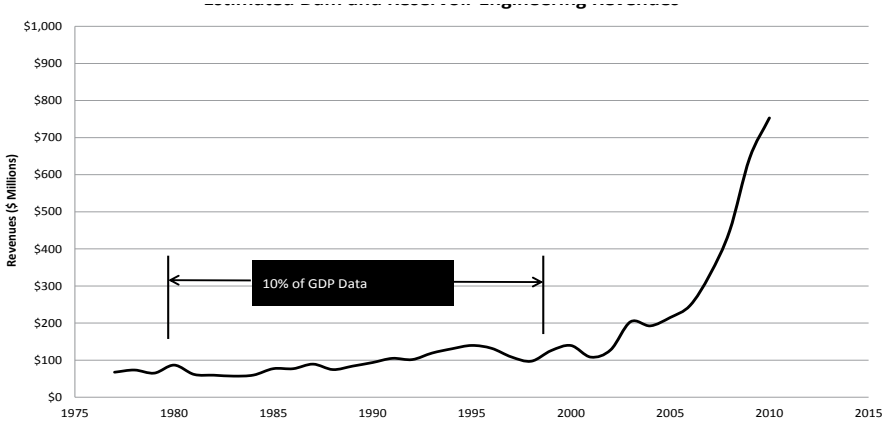
U.S. Dams Market *(Cont. from 8)*

civil construction project, a well documented and accepted percentage for civil engineering projects. This allows a comparison and combination of the GDP data and the ENR data, which is exclusively consulting engineering related revenues. Taking 10 percent of the Figure 2 GDP data to estimate engineering revenues, and including this with the ENR data, a new graph, shown in Figure 3, is generated.

Figure 3: Estimated Dam and Reservoir Engineering Revenues - 1977 to 2010.



There is an obvious correlation with the GDP and ENR data, which gives added evidence that we are experiencing rapid growth in the dams and reservoirs market. Data from other sources, such as conference and investments, are described below.

Dam Related Conference Attendance

U.S. Society on Dams (USSD): Additional data can be found with the U.S. Society on Dams. Larry Stephens, the Executive Director of USSD, has kept excellent records on conference attendance and this can be compared with the ENR data as well. Figure 4 (see Page 10) shows USSD conference attendance combined and compared with the ENR data.

The USSD conference attendance generally matches the ENR data, especially in the last five years when both have increased dramatically.

Association of State Dam Safety Officials (ASDSO): Susan Sorrel provided conference attendance data for ASDSO and similar trends can be seen. There is a general correlation between the ENR dam engineering revenue and ASDSO conference attendance, which both show dramatic increases occurring in the last five years. Figure 5 (see Page 10) shows ASDSO conference attendance combined and compared with the ENR data.

World Bank Dam Related Investment

At its peak in the 1970s, the World Bank was involved in approximately 4 percent of all dam construction projects worldwide. By 2003, this percentage had declined and leveled at 0.6 percent. Also in 2003, the World Bank Board of Directors approved the Water Resources Sector Strategy and has re-engaged in the development and management of water resources infrastructure. This includes the consideration of public and private financial and funding mechanism, project and country/region specific planning, and evaluating the specific needs — and targeted benefits — on a project by project basis. While the impacts of this shift in strategy are still emerging, lending for projects with hydropower elements has increased dramatically since 2003. In 2003, World Bank lending for hydropower projects was $200 million. In 2008, it was just over $100 billion. This represents an increase of over 500 percent in just five years. As with the ENR data, dramatic increases in dam related investment can be seen occurring in the middle of the last decade, providing further evidence of the current expansion of the dams and

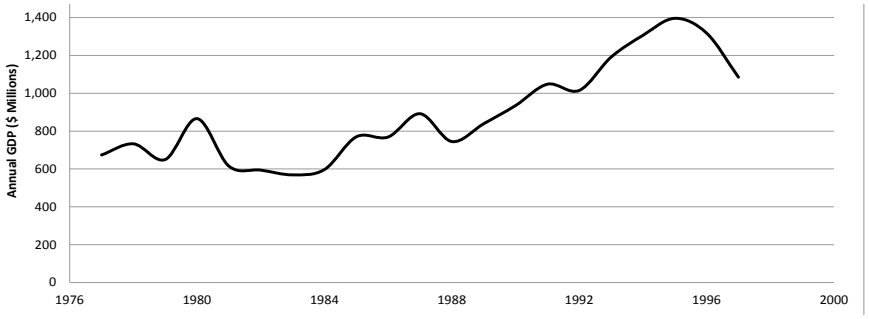


Figure 2: New Dam and Reservoir GDP - 1977 to 1997.

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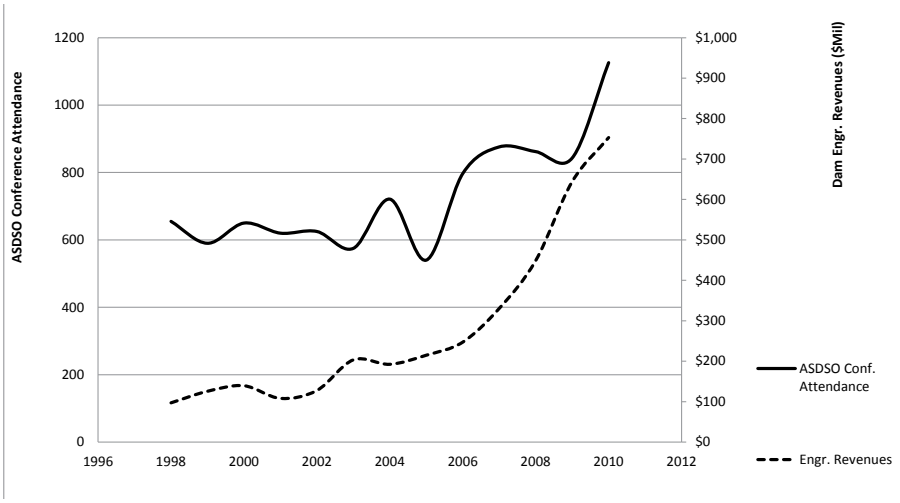
U.S. Dams Market *(Cont. from 9)*

reservoir market.

This data indicates that we are indeed in the middle of a rapid expansion of the dams market. While the data clearly indicates there is market expansion occurring, the reasons behind it are not well defined or understood.

Figure 5: ASDSO Conference Attendance and ENR Dam Engineering Revenues - 1998 to 2010.



Reasons for Recent Market Expansion

Survey Results

A 10 question survey was sent to USSD members asking for their insights into the current and future dams market. It received good response and interest with a total of 127 responses to the survey collected. One question asked respondents to identify the greatest drivers of the dams market and 108 selected Water Supply Concerns. While this category covers a large range of issues, it has been interpreted by the author to encompass all issues surrounding the development and securing of raw water used in our everyday lives. This includes most prominently water for drinking, irrigation, and industrial uses. Figure 6 (see Page 11) shows the responses to Question 9 by category.

American Society of Civil Engineers Infrastructure Report Card – Aging Infrastructure

The first American Society of Civil Engineers (ASCE) report card for our Nation's infrastructure was published in 1998: dams received a "D" letter grade. Subsequent report cards published in 2001, 2003, 2005, and 2009 have also given dams a "D" grade and, according to ASDSO, the number of high hazard deficient dams has swelled from 488 in 2001 to 2,047 in 2008. This report card is generating increased attention as more and more examples of the significant deficiencies with our infrastructure are reported. The failure of the levees in New Orleans during Hurricane Katrina, the catastrophic collapse of the I-35W Bridge in Minneapolis, the explosion of the high pressure natural gas pipeline in San Bruno, California, and the failure of the Taum Sauk Dam in Missouri are just a few examples of catastrophic infrastructure failures in recent years.

Security Concerns

With the heightened concerns surrounding terrorism and its potentially devastating effects on our society, DHS established a Dams Sector in its counterterrorism division tasked with improving the security of our dams against a terrorist attack. With dams

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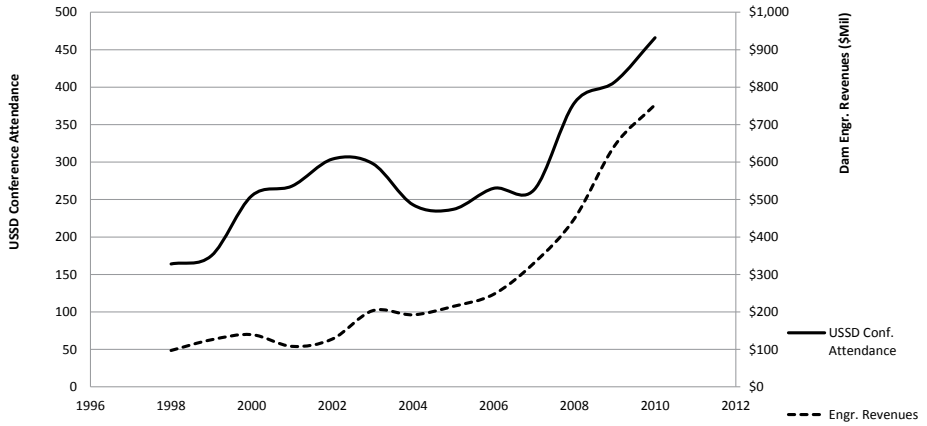


Figure 4: USSD Conference Attendance and ENR Dam Engineering Revenues - 1998 to 2010.

U.S. Dams Market *(Cont. from 10)*

recognized in such a prominent role as a vital component and in need of vigorous protection, they are gaining much needed additional attention and associated funding.

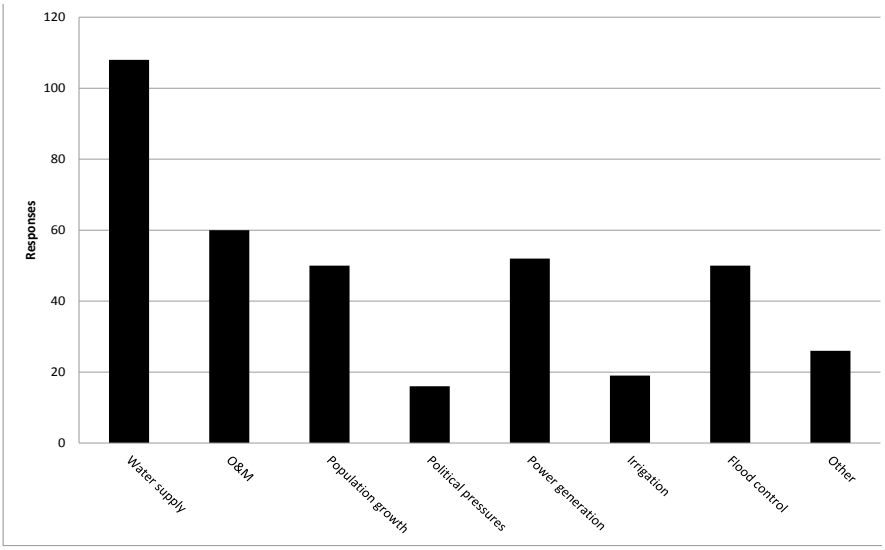
Resurgence of Hydropower

In addition to the World Bank's reinvestment in hydropower, a story published in the *Wall Street Journal* on September 13, 2010 also discussed the reemergence of hydropower as a "green" energy source if implemented in environmentally friendly ways. These include adding small hydro units to some of the more than 85,000 existing dams in the United States as well as new pumped storage schemes. According to the U.S. Department of Energy, a new hydropower project completed in 2016 would produce power at $120 per megawatt hour. This compares very favorably to other "green" energy projects that would be completed at the same time, such as wind power projects, which would produce power at $150 per megawatt hour, or a photovoltaic solar array which would produce power at around $400 per megawatt hour.

From this perspective, hydropower makes excellent economic sense when compared to other renewable energy sources. The upfront capital costs for a hydroelectric plant are typically greater than a fossil fuel plant, but the long-term economic benefits are often far more attractive because dams and hydropower schemes have such long design lives.

Regardless of the reasons or the geographic areas where this work is occurring, the net effect on the dams market appears to be undeniable. The market is expanding and will most likely continue to expand.

Figure 6: Survey Results - Greatest Drivers of the Dams Market.



Future of the Dams Market

There is evidence the health of the dams market will remain strong both in the near- and long-terms, which includes its continued growth and expansion. However, predicting the actual growth of any market is a difficult task for even the most experienced economist or financial advisor, especially if that market has not been previously studied in great detail. Still, this discussion should be occurring among those who work within the dams industry as it will improve our industry as a whole. Improved accuracy in forecasting will provide owners and managers with additional insight into the market and help them make capital expenditure and budgeting decisions that benefit their organizations and ultimately their customers and end users. Similarly, consultants and contractors will benefit from an improved understanding of the market as they make strategic decisions surrounding staffing, mergers and acquisitions, expansions into new markets, commercial expenditures, and so on.

Projection of Data

Annual growth rates in revenues reported in the ENR lists will likely slow in the near-term but will also likely remain positive. According to the ENR, dam engineering related revenue grew at a rate of 17 percent in the most recent lists published this year, and it would not be surprising to see growth rates to slow to below 10 percent in subsequent years.

Figure 7 (see Page 26) projects ENR reported engineering revenue growth beyond 2010 at two different rates — 3 percent and 8 percent. If growth expands at rates

(Continued on Page 26)

Global Dam Safety and Security Challenges

by Katy Yan, International Rivers

With over 54,000 large dams worldwide, dam safety is a major and growing global concern. In a changing climate, dam safety and security is no longer just an issue of aging infrastructure but also of intensifying water conflicts, food security, and appropriate adaptation measures to climate change. Below are just some of the many examples of dam safety and security issues from around the world.

Dam Safety and Earthquakes

While individual dams built today are likely to be much safer than those built 50 years ago, the global stock of dams as a whole is aging. Around the world, 5,000 large dams are at least 50 years old; the average U.S. dam is in its 40s. The two main reasons for dam failures are dam bursts or "overtopping" (responsible for around 40 percent of failures and often a result of flooding) and foundation problems (around 30 percent). Over 12,000 people have been killed this century by dam-bursts outside of China for which data are available[1] (within China, the worst dam burst disaster occurred in 1975 in Henan province, where official estimates say at least 26,000 people died from the incident).[2]

While earthquakes have damaged hundreds of dams, dams can also trigger earthquakes in a phenomenon known as Reservoir-Induced Seismicity (RIS). Globally, there are over 100 identified RIS cases.[3] The most widely accepted explanation of how dams cause earthquakes is related to the extra water pressure created in the micro-cracks and fissures in the ground under and near a reservoir. When the pressure of the water in the rocks increases, it acts to lubricate faults that are already under tectonic strain, but are prevented from slipping by the friction of the rock surfaces.[4]

The most serious case may be the 7.9-magnitude Sichuan earthquake in May 2008, which killed an estimated 80,000 people and has been linked to the construction of the Zipingpu Dam. After the earthquake struck, the Ministry of Water Resources reported that as many as 2,380 dams were damaged in the earthquake. Scientists in China and the United States fear that the earthquake may have been induced by the weight of the Zipingpu reservoir.[5] Despite these concerns, China continues to plan major dam projects in its seismically active southwest.

Dams and Food Security

The impact that dam building could have on regional food security is no more evident than in the Mekong basin in Southeast Asia. The Mekong River flows through Thailand, Laos, Cambodia, and Vietnam, and supports the world's largest inland fishery. Its economic worth at first-sale value is at least $2 billion per year and up to $9.4 billion per year, taking into account secondary industries.

Food security forms the basis upon which other forms of development are built, such as good health, education, and productivity. Wild-capture fisheries are especially important to those rural families that have limited access to land and other productive resources and with

(Continued on Page 13)

1. P. McCully, *Silenced Rivers*, Zed Books Ltd, New York, (2001), 117.
2. Fu Wen, "Reservoirs Dogged," *Global Times*, (August 26, 2011), http://www.globaltimes.cn/NEWS/tabid/99/ID/672685/Reservoirs-dogged.aspx.
3. H.K. Gupta, "A Review of Recent Studies of Triggered Earthquakes by Artificial Water Reservoirs with Special Emphasis on Earthquakes in Koyna, India," *Earth-Science Reviews*, 58 (3-4) (2002), 279-310, http://www.sciencedirect.com/science/article/pii/S0012825202000636.
4. V.P. Jauhari, Prepared for Thematic Review IV.5, "Options Assessment – Large Dams in India Operation, Monitoring, and Decommissioning of Dams," (1999), http://www.dams.org.
5. Gautam Naik and Shai Oster, "Scientists Link China's Dam to Earthquake, Renewing Debate," *The Wall Street Journal*, (February 6, 2009), http://online.wsj.com/article/SB123391567210056475.html.

Global Challenges *(Cont. from 12)*

a low monetary income.[6] However, the governments of Cambodia, Laos, and Thailand are considering plans to build 11 large hydropower dams on the Mekong River's lower mainstream. If built, these dams would block the major fish migrations that are essential to the life cycle of around 70 percent of the Mekong River's commercial fish catch.

For instance, a report published in 2009,[7] revealed that the first dam planned for the lower Mekong, the Don Sahong Dam in southern Laos, would block the migration of many important fish species that move up and down the Mekong River throughout the year. As a result, the dam could seriously impact fisheries as far upstream as northern Laos and northern Thailand, and fish populations downstream would also be threatened, including important fisheries in the Tonle Sap in Cambodia and the Mekong Delta in Vietnam. In addition, the government of Laos is currently proposing to build the Xayaburi Dam despite opposition by its neighbors and civil society. A technical review[8] in March 2011 by the Mekong River Commission could lead to the extinction of approximately 41 fish species, including the critically endangered Mekong Giant Catfish. These impacts in turn would affect the livelihoods and food security of millions of people in the region.

Regional and International Security

History is filled with examples of international disputes over shared freshwater resources.[9] For instance, in the Middle East, hydropower and agricultural developments on the Euphrates River have been the source of considerable international concern. This river flows from the mountains of southern Turkey through Syria to Iraq before emptying into the Persian Gulf. Both Syria and Iraq depend heavily on the Euphrates River for drinking water, irrigation, industrial uses, and hydropower, and view Turkey's upstream dam development plans with great concern. When all of Turkey's projects are complete, the flow of the Euphrates River to Syria could be reduced by up to 40 percent, and to Iraq by up to 80 percent.[10]

Similarly, countries downstream of China are concerned that China's dam building upstream of major transboundary rivers such as the Mekong, the Salween, and the Brahmaputra rivers could leave thousands of communities downstream in Myanmar, India, and the greater Mekong region stranded without dependable water for their fields and fisheries. For instance, China intends to build as many as five dams on the middle reaches of the Yarlung Zangbo (known as the Brahmaputra in India). The 510 MW Zangmu hydroelectric power station is already underway,[11] and talk about a massive project at the Great Bend (which would be twice the size of the Three Gorges Hydroelectric Project) is causing serious concern and speculation in India.

Challenges in a Changing Climate

Dam designers work on the assumption that historic hydrological variables such as average annual flow, annual variability of flow, and seasonal distribution of flow are a reliable guide to the future. As global temperatures increase, however, there are likely to be significant changes in seasonal and annual rainfall patterns and other factors affecting streamflow.[12] Most of the world's dams have not been built to allow for the erratic hydrological patterns that climate change is bringing. More extreme storms and increasingly severe floods will have major implications for dam safety. Floods exacerbated by dam bursts

(Continued on Page 27)

6. B. Peterson and C. Middleton, *Feeding Southeast Asia: Mekong River Fisheries and Regional Food Security*, International Rivers, (2010), http://www.internationalrivers.org/en/node/5637.
7. I. Baird, *The Don Sahong Dam: Potential Impacts on Regional Fish Migrations, Livelihoods and Human Health*, (2009), http://www.internationalrivers.org/node/4595.
8. Mekong River Commission Secretariat, *Prior Consultation Project Review Report: Proposed Xayaburi Dam Project – Mekong River*, (March 24, 2011), http://www.mrcmekong.org/pnpca/2011-03-24_MRCS_PC_Review_Report.pdf.
9. P.H. Gleick, "Water and Conflict," *International Security*, 18 (1), (1993), 79-112.c.
10. Ibid, p88.
11. Jiang Yannan and He Haining, "A New Era for Tibet's Rivers," *chinadialogue*, (January 17, 2011), http://www.chinadialogue.net/article/show/single/en/4055.
12. McCully, p.145.

Risk Assessment and Dam Safety

by Shane McGrath, General Manager Infrastructure, Goulburn-Murray Water, State of Victoria, Australia*

Introduction

Over the past decade, risk assessment has been widely used in Australia to support dam safety programs. It is broadly accepted that risk assessment can provide a rational framework for decision-making when the type of analysis and associated detail is appropriate for the issues to be resolved. In particular, the use of risk assessment to determine the priority, urgency, and extent of remedial works across a portfolio or at a single dam is seen as particularly valuable.

Regulation

Australia has a federal system of government, whereby powers are divided between the central government and individual states. Dam safety is a matter for the six State and two Territory Governments. Currently, four States and one Territory have specific dam safety regulations. Risk assessment is permitted in three States and one Territory and is also being extensively used in the other jurisdictions.

A Dam Improvement Program

Goulburn-Murray Water is a rural water corporation in the State of Victoria. It has responsibility for operation, maintenance, renewal, and dam safety programs for 16 dams. The dam portfolio is diverse, ranging from relatively small earthen embankments to the highest dam in Australia. The age profile is from 15 to 140 years and the dams have a current replacement cost of AUD $5 billion.

Goulburn-Murray Water established a Dam Improvement Program in late 1997. The program originally developed a strategy to reduce the risk posed by Goulburn-Murray Water's dams using risk assessment with varying levels of assessment for the purposes of determining investigation and works priorities.[1]

The strategy used an initial risk assessment process, commonly referred to as "portfolio risk assessment" to determine design review priorities and to provide an indication of potential works. Following the completion of design reviews, a detailed quantitative risk assessment has been used to:

- Assist in determining the severity of a risk by comparing the calculated risk to indicative targets for tolerable risk to life and then deciding an appropriate time frame for reducing risk;
- Assist in devising interim, or short-term, risk reduction measures that achieve a level of tolerable risk until funds are available to undertake standards based works; and
- Assist in deciding when business risks might be addressed ahead of low risks to life.

The process of detailed risk assessment and developing a risk reduction program had to meet the following requirements:

- Clearly present the current status of risk and how cost effective measures could be implemented to reduce risk;
- Be subject to expert review and allow for inputs regarding consequence assessments by key stakeholders;
- Be to a level of detail that would provide for confidence in decision-making and be defendable under scrutiny; and
- Provide base data for the evaluation of risk reduction and provide associated data for insurance purposes.

For each dam, a staged approach to risk reduction has been adopted.

(Continued on Page 15)

1. D. Stewart, S. McGrath, and D. Nabbs, *Prioritisation of Dam Safety Management in a Large Water Business*, ICOLD International Symposium on Dam Safety Management, St Petersburg, (2007).

Dam Safety *(Cont. from 14)*

The risk reduction strategy is based on progressively reducing risks across the portfolio to meet interim risk targets as follows:

First Risk Target: Reduce all risks below the ANCOLD (Australian National Committee on Large Dams) Guidelines on Risk Assessment[2] limit of tolerability for risk to life safety.

Second Risk Target: Reduce risks classified 1 or 2 to a Rating 3 or better under the Goulburn-Murray Water Whole of Business Risk Management Framework (dam safety risk is compared to other high business risks).

Third Risk Target: Reduce risks classified as a Rating 3 to a Rating 4 or better under the Whole of Business Risk Management Framework (further risk reduction based on relative business priorities). Detailed assessment of ALARP criteria has not yet been undertaken.

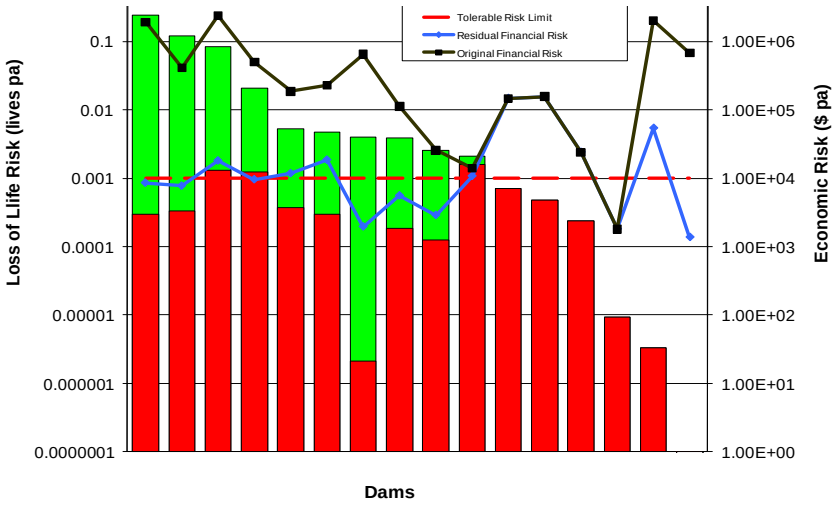
Fourth Risk Target: If required, upgrade dams to standards-based criteria.

This approach allows for risks to be reduced in a rational and cost effective way, undertaking the projects generally as ranked from highest to lowest risk.

The first risk target provides for the regulatory requirement to give priority to risks to life ahead of other risks. Subsequent risk targets enable remaining risks to be assessed and prioritised alongside risks other than dam safety risks faced by the Authority.

Guidelines for determining the timeframe for upgrade works have been developed. Timing for commencement of upgrade works are based on the magnitude of risks and are determined relative to the time the deficiency was identified.

Since 1997, Goulburn-Murray Water has invested AUD $125 Million on 14 risk reduction projects across its portfolio of dams. The graph (see below) indicates the extent of risk reduction achieved. This has included staging works at individual dams to ensure higher priority risks at other sites were addressed in the most efficient way.



Reducing "Tolerable" Risks

Several dam owning agencies in Australia have now reduced risk across their portfolios to the extent that most, or all, dams have calculated risk levels below the "limit of tolerability."[3] If a pure risk-based approach is to be used, then the "As Low as Reasonably Practicable" (ALARP) test should now be applied to each dam to ascertain whether risk has been reduced sufficiently. ANCOLD suggests that the following points are relevant to the consideration of ALARP:

- Cost-to-save-a-statistical-life (CSSL) is a consideration for life safety risks;
- Whether good practice is met is a consideration;
- The level of existing risk is a consideration;
- Societal concerns may be a consideration;
- Affordability is not a consideration for life safety risks; and
- Duration that the risk applies may not be a consideration for life safety risks in some circumstances.

(Continued on Page 16)

2. Australian National Committee on Large Dams (ANCOLD), *Guidelines on Risk Assessment*, 2003.
3. Ibid.

Dam Safety *(Cont. from 15)*

The evaluation of ALARP for dams does not yet have a depth and range of an accepted body of work to provide owners with a sound methodology to work through.

This is not unexpected since the ALARP principle is not a technical concept, but was established in law in Britain in 1949. ANCOLD includes the statement that "there is no 'formula' by which to decide that risks are ALARP" and "the owner can treat CSSL as one consideration, but must ultimately make, and take responsibility for, the judgement that the sacrifice is grossly disproportionate to the benefit gained in terms of risk reduction."[4] This is a demanding process and it is not to be expected that the determination of ALARP is a simple matter. The determination of what constitutes "good practice" is particularly challenging.

Recently, it has been suggested[5] that the dam owners in Australia may be over-investing in dam safety. This view appears to be based principally on the measurement of CSSL for dam safety upgrade projects compared to other investments in public safety. It is a function of the mathematical determination of CSSL that for any dam which has risks just lower than the "limit of tolerability," other than minor investment in risk reduction, it will have poor justification. However, a focus on the value of CSSL seems to ignore the broader tests required in the consideration of ALARP, for example, the consideration of "good practice."

An approach to ALARP only considering CSSL will generally result in risk at any dam not being reduced significantly once a risk position just below the limit of tolerability is reached. Whilst this situation may be a reasonable outcome for some dams and satisfy the tests for ALARP, it is unlikely that it would be considered a reasonable approach for an extreme hazard dam where nationally significant consequences of loss of life, environmental, or economic damage would result from dam failure.

Safety Case

In the author's view, once risks at a dam or portfolio of dams have been reduced to below the limit of tolerability, a "safety case" should be prepared for each dam that sets out the rationale supporting further risk reduction or for normal operations to continue for the time being. For example, the safety case would be a comprehensive document that would include the following:

- Management System Approach: Outlining all activities and methodologies in place to ensure that the dam is operated and maintained safely, including emergency plans, operations, surveillance, and maintenance manuals, flood management plans, risk assessments, and the regular safety review;
- All base data for the dam;
- Surveillance results and analysis;
- Site investigation findings;
- Safety review results;
- Risk assessment results, including probabilities and consequences; and
- A concise report setting out the defensive mechanisms in place to deal with all identified failure modes and the rationale to continue normal operations or for further risk reduction at the dam.

Whilst the comparison of risk positions with respect to tolerability criteria and the calculation of CSSL may form part of the report, such constructs may not provide sufficient support for the defence should a failure occur. It is possible that a more sophisticated "safety case" approach is necessary that can be understood as appropriate for the protection of public safety by a "reasonable" person.

Conclusion

Risk assessment is an extremely valuable tool for determining the priority and urgency of works. Combined with tolerable risk criteria, a logical framework for cost-effective and timely risk reduction can be assembled. However, in a dam safety program, risk assessment is but one tool within a comprehensive dam safety system, covering all facets of operations and maintenance.

The reliance on calculated risk and

(Continued on Page 29)

4. Ibid.
5. J. Marsden, L. McDonald, D. Bowles, R. Davidson, and R. Nathan, *Dam Safety, Economic Regulation and Society's Need to Prioritise Health and Safety Expenditures, NZSOLD ANCOLD Workshop*, "Promoting and Ensuring the Culture of Dam Safety," Queenstown, (2007).

Sustainable Hydropower's Role in Global Security

by Richard Taylor, Executive Director, International Hydropower Association

The need for a new approach to security, one which includes new paradigms such as environmental issues, food, water, and human security, above and beyond the more traditional military concepts of security, has in recent years been garnering growing recognition.

Climate change threatens to impact many of the diverse definitions of security and logically therefore should be considered a global security issue of the highest importance itself. Challenges in meeting the current, let alone increasing, needs and expectations of the developing world on water, energy, and food supplies will be compounded by the impacts of climate change — needs and expectations that if not met have the potential to rapidly become significant security challenges.

As the percentage of the world's population living in cities dramatically increases (for example, the United Nations Human Settlements Programme estimates in the *State of African Cities 2010: Governance, Inequalities and Urban Land Markets* that "[a]frican city populations will more than triple over the next 40 years," from around 395 million in 2009 to around 1.23 billion in 2050), the vital importance of getting the interaction between the water/energy/food nexus and the impacts of climate change right to ensure human wellbeing and global security, can only increase.

The significance of these points has not been lost by key decision-makers.

As far back as 2004, the United Kingdom Government's Chief Scientific Advisor, Sir David King, stated "[c]limate change is a far greater threat to the world's stability than international terrorism." Achim Steiner, Executive Director of the UN Environment Programme, in a statement in July of this year agreed that "[t]here can be little doubt today that climate change has potentially far-reaching implications for global stability and security in economic, social and environmental terms which will increasingly transcend the capacity of individual nation States to manage."

Addressing the links between energy security, water security, and food security requires an intense focus on sustainability as a strategic imperative. Hydropower as an advanced, renewable energy source is a nexus that connects all three, and has a key role to play in addressing these challenges. The importance of hydropower in making a significant contribution to climate change mitigation and adaptation therefore demonstrates it has much to offer in the area of global security.

Further developing hydropower potential in regions, that in some cases have enormous untapped potential, would help meet a substantial portion of growing energy demands, demands spurred by the quest for sustainable development. At the same time, developing this potential sustainably allows for improved water management. Reservoirs that form part of hydropower infrastructure have multiple advantages, including enhancing water security, providing flood mitigation and water for irrigation, tourism and recreational facilities, as well as new aquatic habitats. Better water management and the provision of water for irrigation in turn can help bolster food security.

In these ways, hydropower presents an opportunity to boost economies and human well-being, but it must be developed sustainably. The hydropower sector has lacked a comprehensive, globally applicable tool to assess and demonstrate the sustainability of hydropower projects — a point that was highlighted by the World Commission on Dams Final Report in 2000.

In 2008, the hydropower sector

(Continued on Page 18)

Hydropower*(Cont. from 17)*

began working with diverse partners to define a sustainability assessment tool that would meet this need. The outcome was the *Hydropower Sustainability Assessment Protocol*, developed by a multi-stakeholder body known as the Hydropower Sustainability Assessment Forum over a period of 30 months. This Forum consisted of representatives from social and environmental NGOs (Oxfam, The Nature Conservancy, Transparency International, and World Wildlife Fund); governments (China, Germany [observer], Iceland, Norway, and Zambia); commercial and development banks (including banks that are signatory to the Equator Principles and the World Bank [observer]); and the hydropower sector, represented by International Hydropower Association (IHA).

Field trials were conducted in 16 countries, across six continents, and 1,933 individual stakeholders in 28 countries were engaged as part of the development process (see Figure 1). The Forum incorporated fieldwork in China and Zambia in working with affected communities, as well as consulting affected communities during both of the two review phases of the Protocol, and worked with them during the trialling of the draft Protocol. These efforts, and the learning developed through them, strongly influenced the final version of the Protocol, launched in June 2011 in Iguassu, Brazil.

As Dr. Joerg Hartmann, Water Security Leader at WWF International and a Forum member, stated, "[f]or years, the environmental community has been looking for industry leadership to raise the environmental performance of hydro projects, and to avoid bad projects altogether. Industry awareness is certainly increasing, but there is still an urgent need for practical tools in the field. Working with IHA on the Protocol has already proven to be a very effective way for WWF to reach a broad group of utilities, investors and regulators."

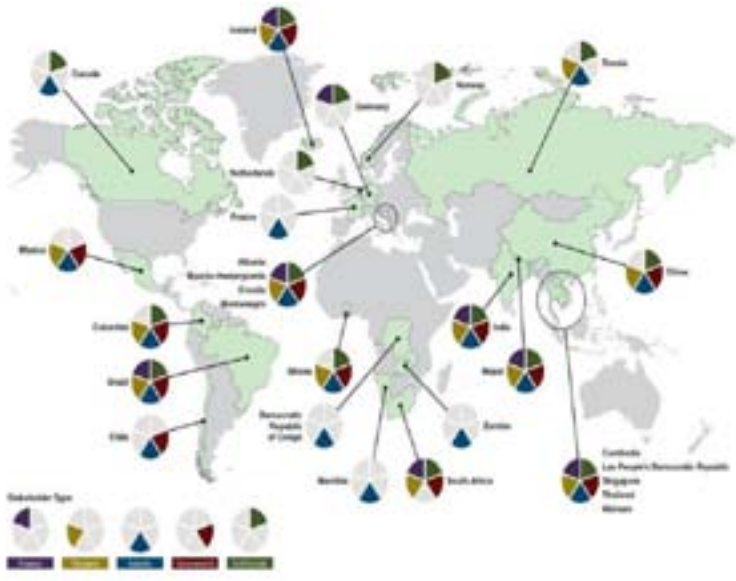


Figure 1: Hydropower Sustainability Assessment Forum Stakeholder Engagement Activities

Sustainability Profile

The Protocol offers the proponent of a hydropower project a consistent, globally-applicable method of assessing performance in approximately 20 (depending on the stage being assessed) sustainability topics. These topics cover the three recognised pillars of sustainability: social, economic, and environmental, and include issues such as downstream flow regimes, indigenous peoples, biodiversity, infrastructure safety, resettlement, water quality, and economic viability (see Table 1 on Page 19).

Independent, accredited assessors will conduct Protocol assessments after undergoing comprehensive training. Using the Protocol tools as a framework, assessors produce a sustainability profile of a project. This profile can then be used to foster better understanding among, and increased dialogue between, multiple stakeholders.

An assessment can be conducted during any stage of a project from planning to operation. Commissioning an assessment gives a project developer, and others, insights into areas that may need improvements in sustainability. However, as it is not a standard, it does not automatically enable them to claim that their project is sustainable.

Regardless, according to Dr. Donal

(Continued on Page 19)

Hydropower*(Cont. from 18)*

O`Leary, Senior Advisor of Transparency International (TI), and a Forum member, "[f]or the first time, the issues of governance, transparency, integrity and accountability were addressed in the Hydropower Sustainability Assessment Protocol. This will significantly facilitate the sustainability of the planning, design, implementation and operation of hydroelectric projects."

The ability to rapidly interpret and transparently communicate the results of a project assessment, based on documented evidence and thorough objective analysis, is key to ensuring that the Protocol is useful to a wide variety of stakeholders. Therefore, results are presented using a standardised structure and diagram, resembling a spider diagram, showing a scoring between 1 and 5 for each of the sustainability topics (See Figure 2 on Page 20).

This new approach to promote continuous improvement in hydropower sustainability has been designed so that the sustainability of hydropower projects can be assessed anywhere in the world, covering a broad range of possible case scenarios, making it a potentially valuable tool for investors and other financial institutions operating across diverse geographies.

Governance

The Protocol is governed by a multi-stakeholder Governance Committee, currently chaired by Dr. Joerg Hartmann (WWF International). The Committee receives its mandate from the *Hydropower Sustainability Assessment Council Charter*, drafted by members of the Hydropower Sustainability Assessment Forum, the body responsible for drafting the Protocol between 2008 and 2010.

Table 1: Example of Range of Topics

Integrative	Environmental	Social	Technical	Economic / Financial
Demonstrated Need	Downstream Flow Regimes	Resettlement	Siting & Design	Financial Viability
Policies & Plans	Erosion & Sedimentation	Indigenous Peoples	Hydrological Resource	Economic Viability
Governance	Water Quality	Public Health	Infrastructure Safety	Project Benefits
Integrated Project Management	Biodiversity & Invasive Species	Cultural Heritage	Asset Reliability & Efficiency	Procurement

The Governance Committee's authority extends to:

- Approving any changes to the Protocol;
- Ensuring that assessments constitute appropriate applications of the Protocol;
- The development of training materials;
- Accreditation of assessors; and
- Any revisions to the Terms and Conditions

Governance Committee members are elected from expert groups referred to as "Chambers," representing environment or conservation organisations; project affected communities and indigenous peoples' organisations; financial institutions; developing country governments; industry; and developed country governments. In a direct effort to foster inclusiveness, the Governance Committee welcomes and encourages input from, and engagement with, stakeholders involved in the development of hydropower throughout the world.

Sustainability Partnerships

Sustainability Partners receive a number of benefits for taking the initiative in advancing sustainable hydropower. For example, they are trained on the content of the Protocol and how to apply it, and offered an unofficial Protocol assessment, an official Protocol assessment, or both. Sustainability Partner models remain somewhat flexible to allow for the needs of differing participating organisations.

Ten organisations, representing operations across the globe, have

(Continued on Page 20)

Hydropower*(Cont. from 19)*

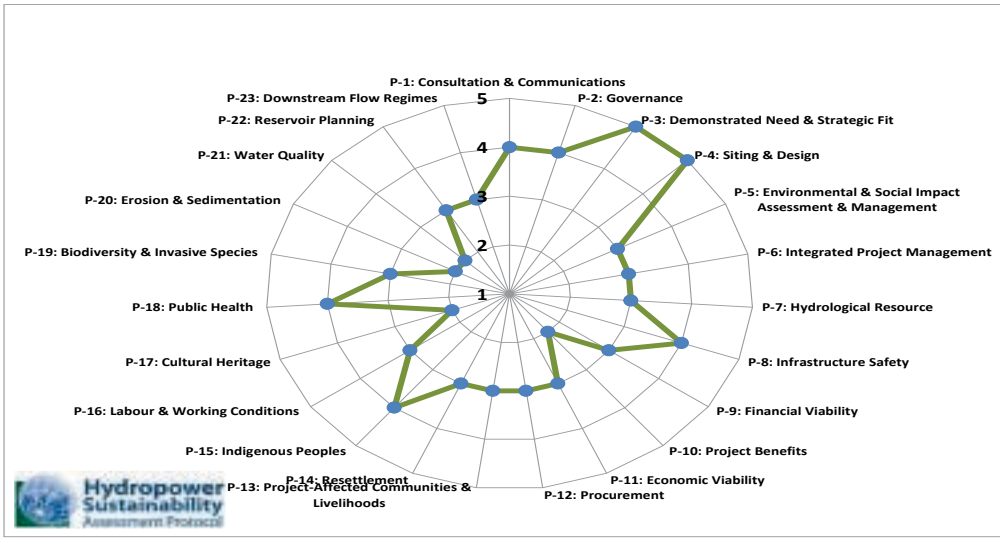
already become IHA Sustainability Partners: Environmental Defense Fund, E.ON, Itaipu Binacional, Hydro Equipment Association, Hydro Tasmania, Landsvirkjun, Manitoba Hydro, Odebrecht, Sarawak Energy, and Statkraft.

"By partnering with IHA on implementing the Protocol, Sustainability Partners are demonstrating their commitment to sustainable, and therefore increasingly secure, hydropower development," said Dr. Refaat Abdel-Malek, President of IHA.

This positive response from the hydropower industry demonstrates the wide interest in applying the Protocol among companies keen to promote continuous improvement of hydropower sustainability performance.

IHA's *Hydro4LIFE* project will form the basis for Sustainability Partners, whose projects for assessment using the *Hydropower Sustainability Assessment Protocol* are situated within the European Union. *Hydro4LIFE* is a European Commission-funded project to assist the implementation of the *Hydropower Sustainability Assessment Protocol* in the European Union. The project is 50 percent co-funded by the European Commission's Life+ Environment Policy and Governance Programme, and 50 perecent by IHA, with a total budget of €1.2 million. It is coordinated by IHA and runs until 2014. The approach requires that

Figure 2: Sustainability Profile: An Example Presentation of Results



match funding be provided by leading hydropower organisations. More information on the *Hydropower Sustainability Assessment Protocol*, including downloadable copies, can be sourced by visiting: www.hydrosustainability.org.

Sustainable Hydropower's Potential

Water and energy are vital for economic growth and stability, and directly affect the prices of goods and services that their presence makes possible. Although energy provision is not specifically a UN Millennium Development Goal (MDG), it nonetheless underwrites a number of these goals. Achieving the MDGs will be virtually impossible without addressing water and energy issues to ensure resilient, consistent, and reliable supplies of both.

There are major benefits from hydropower at the local, regional, and global level as a source of clean, renewable, and low-carbon energy. Hydropower will continue to play a fundamental role in both water and energy supply, forming the nexus where energy and water issues meet, and where challenges can be overcome, provided development is carried out responsibly.

As decision-makers, particularly in the developing world, seek to improve their water and energy security, they are reassessing their country's hydropower potential and the contribution it can make to climate change mitigation and adaptation. A tool, such as the *Hydropower Sustainability Assessment Protocol*, which comprehensively assesses and demonstrates the sustainability of hydropower projects, will be a useful addition to their policy development toolkit. The Protocol therefore offers an opportunity to enhance infrastructure security, water and energy security, and so has positive implications for global security. ❖

The International Hydropower Association (IHA) was formed under the auspices of UNESCO in 1995

(Continued on Page 25)

Grand Ethiopian Renaissance Dam: Challenges and Opportunities

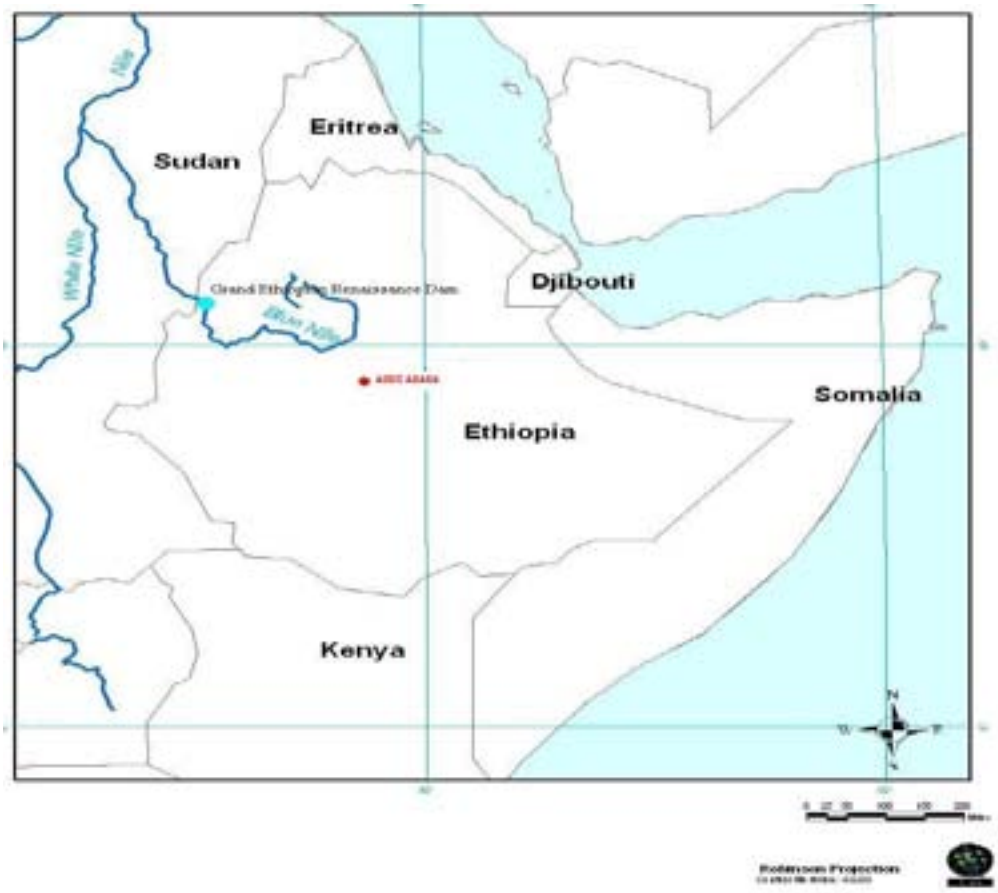
by Salman M. A. Salman*

Introduction

In March 2011, the Government of Ethiopia announced to the world that it plans to start construction of the Grand Ethiopian Renaissance Dam on the Blue Nile near the borders with the Sudan. The dam would be the largest dam in Africa, and the tenth largest in the world. This article reviews Ethiopia's dam construction program, with particular attention to the challenges posed, and opportunities provided, by the Grand Ethiopian Renaissance Dam.

Water Resources of Ethiopia

Ethiopia is one of the countries that is classified as rich in water resources. Its renewable water resources exceed 122 billion cubic meters (BCM) per annum, with a per capita of 2,000 cubic meters; making it the richest country in Africa after the Democratic Republic of Congo. The country is endowed with 12 river basins, 22 lakes, and a large quantity of mostly untapped groundwater. The 12 river basins can be classified into four separate river systems. The Awash River originates and flows through the eastern plateau, and ends in the wetlands shared with Djibouti, making Djibouti a riparian state. The Wabe Shebelle, Genale, and Juba basins dominate the central plateau, and are shared with Somalia, while Kenya shares the Dawa tributary of the Juba River. The Omo River flows through the southern plateau of Ethiopia and empties into LakeTurkana that falls largely within Kenya, with only its small northern edge falling into Ethiopia. The Nile River system dominates the western plateau from the upper northern to the southern reaches, and consists of three basins: the Tekeze/Atbara in the northern part, the Abbay/Blue Nile in the central part, both flowing into the Sudan and becoming part of the Nile river, and the Baro/ Akobo/Sobat Basin that originates in the southern western plateau and flows into South Sudan where it joins the White Nile. The Nile river basin is shared by 11 countries, namely Democratic Republic of Congo,



Map of Ethiopia and the Blue Nile with an approximate location of the Grand Ethiopian Renaissance Dam. This map was produced by Patricia Boudinot, an Instructor for the Geography and Geoinformation Science Department at George Mason University, using ArcMap software.

(Continued on Page 22)

Ethiopia *(Cont. from 21)*

Burundi, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania, and Uganda. Ethiopia is the source of about 72.5 BCM or 86 percent of the total Nile waters of 84 BCM measured at Aswan (59 percent Blue Nile, 14 percent Sobat, and 13 percent Atbara). The remaining 11.5 BCM, or 14 percent of the Nile waters flow from the White Nile, and originate from the equatorial lakes, particularly Lake Victoria which is shared by Tanzania (49 percent), Uganda (45 percent), and Kenya (6 percent).

In addition to the fact that its 12 river basins are shared with 12 other riparians, Ethiopia faces the challenges of climate change (floods and drought), environmental degradation, including massive soil erosion, and population growth. Indeed the population of Ethiopia has reached close to 88 million this year, surpassing that of Egypt of 84 million.

History of Dam Building in Ethiopia

Despite its richness in water resources, Ethiopia has been, until recently, one of the poorest countries, with one of the lowest per capita water storage and electricity production in the world. Since 1960, Ethiopia wasted massive financial and human resources in wars against Eritrea and Somalia, and internally against itself. It was only at the beginning of this century that Ethiopia has been, for the first time, not engaged in an active war, although opposition to the current regime remains wide, and an armed movement still roams parts of the Ogaden region.

The studies undertaken in the 1950s and 1960s indicated the huge potential for hydro-power in Ethiopia, estimated at 45,000 megawatt, with close to two thirds of that amount from the Nile river system alone. However, with the wars and poor economic situation, not much was done to harness this massive hydro-power potential. Few small dams for generation of limited hydropower were constructed in the 1960s and 1970s, including the Fincha Dam on the Blue Nile (total hydropower of 80 megawatt); Koka Dam on the Awash (total hydropower of 40 megawatt); Melka Wakena Dam on Wabe Shebelle (total hydropower of 150 megawatt); Tis Abbay (First and Second dams) at Lake Tana (with a total hydropower of 75 megawatt); and Sur Dam on the Baro (total hydropower of 40 megawatt). By the close of last century in 2000, Ethiopia's total hydropower production was less than 400 megawatt, and the irrigated area from the 12 river basins was less than 70,000 acres.

However, with the relative peace, improvement in relations with the west, and considerable increase in the world coffee prices, Ethiopia launched a very ambitious development program at the beginning of this century, which includes a number of large dams. This program is facilitated by the discovery and development of natural gas in the Ogaden region of Ethiopia, and by the emergence of the People's Republic of China as a dam builder and financier and as an economic power, hungrily searching for natural resources across the globe.

Dams on the Omo River

Ethiopia started its ambitious large dam construction program on the Omo River. It chose the Omo River because it has a huge potential, and also has the least controversies with the other riparians. Dam projects on the Omo River would affect Lake Turkana which is shared with Kenya, but Kenya itself has also contributed to the decrease of the flow of its own rivers that empty into the Lake. Moreover, Kenya is desperately in need of electricity, and the Omo river hydropower of Ethiopia is close, cheap, and large in volume. The Turkana tribe would be negatively affected by the Ethiopia dams program on the Omo River, and indeed this has caused a number of donors to refuse to finance those dams. Nevertheless, Ethiopia is proceeding with its dam building program on the Omo River.

Ethiopia completed the first project on the Omo River, called the Gilgel Gibe project, in 2004, with the help of the Italian company Salini, for generation of 180 megawatt of electricity. It constructed the second Gilgel Gibe project, again with the help of Salini in 2003, and completed it in 2010, for generation of 400 megawatt. The third Gilgel Gibe project, which was started in 2006, has run into huge local and international opposition because of its expected negative environmental and social effects on the Lake and the Turkana

(Continued on Page 23)

Ethiopia *(Cont. from 22)*

people. Ethiopia now claims that those issues have been adequately addressed, and the project would be completed with the financial assistance and construction help of China in 2012, for generation of 1,900 megawatt. Two more projects on the Omo River, Gilgel Gibe four and five, for generation of 1,500 and 600 megawatt respectively, are currently at an advanced stage of studies, with the help of China.

Dams on the Nile River System

As indicated above, Ethiopia constructed two small dams on the Blue Nile (Fincha), and Lake Tana (Tis Abbay). However, it started the first large dam, the Tekeze Dam, in 2002 on the Tekeze/Atbara River. This dam, which China assisted in construction and financing (costing $360 million), was completed in 2010, with a height of 188 meters and a reservoir capacity of 4 BCM. This is a major achievement for Ethiopia, as it was able to erode the hegemony of Egypt and Sudan over the Nile River by completing this large dam. This dam was followed by the Tana Beles dam, where water is being diverted from Lake Tana to the Beles River, and a hydropower station is built, with the help of Salini, at the junction for generation of 460 megawatt. Ethiopia plans a huge dam construction program, covering 17 large dams, nine of which are planned on the Nile River system. Those nine dams include the Border, Karadobi, Mendaya, Mabil and Dobus dams, as well as the Grand Renaissance Dam, discussed below.

The Grand Renaissance Dam

The announcement about the Grand Renaissance Dam, made last March, indicated that the dam would be constructed on the Blue Nile about 40 kilometers from the borders with the Sudan. It is expected to generate 5,250 megawatt of electricity, create a reservoir that would hold 62 BCM of water, and cost close to $5 billion. The generating capacity is almost twice that of the Hoover Dam, and close to that of Robert-Bousara, Canada's largest hydro-power plant. The size of the reservoir would be almost double the size of Lake Tana (the origin of the Blue Nile), and close to half the size of Lake Nasser of the Aswan High Dam in Egypt. Construction is expected to start this year, and be completed in 2016. Either Salini or China, or both, could be involved with the construction and financing, although the Ethiopian government indicated that it would raise the cost through publicly issued bonds. If this project and the other Omo River projects are completed on time, Ethiopia hydro-power production would rise in that year (2016) to about 10,000 megawatt.

The announcement about this dam was made in March 2011, a few weeks after Egypt was engulfed in and became busy with its revolution, indicating the intricate hydro-politics of the Nile basin. Both Egypt and Sudan initially opposed the dam as harmful to their interests, and as a violation of the 1902 Agreement between Britain and Ethiopia, under which Ethiopia agreed not to construct any works on the Nile or its tributaries which would negatively affect Egypt without Egypt's consent. Ethiopia has long claimed that the English version of this agreement was different from the Amharic version, and at any rate, the agreement was not ratified by Ethiopia. Egypt disagrees and claims that the agreement is valid and binding on Ethiopia.

Ethiopia claims that the Grand Renaissance Dam would actually be beneficial to Egypt and Sudan. It states that the Dam would regulate the flow of the Nile and end the devastating floods, particularly in the Sudan. It would also trap the huge amounts of sediments that are negatively affecting the dams in the Sudan and Egypt. Given its location in a deep valley, and the weather in that area, Ethiopia states that evaporation losses would be minimal, compared to the huge evaporation losses of the dams in Egypt and Sudan. It also claims that the cheap electricity that would be generated by the dam could be sold to Egypt and Sudan, and that Sudan could even expand its irrigated agriculture in the border areas by taking water from the reservoir. Ethiopia indicated that it is willing to have the project jointly funded and operated with Egypt and Sudan.

Egypt and Sudan voiced their opposition to the project and demanded copies of the studies for the project to ascertain its effects. However, on May 2011, a large Egyptian delegation visited Ethiopia, and this was followed by a

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Legal Insights

Morganza Spillway and the Flowage Easement

The Morganza Spillway and the 2011 Mississippi River Flooding

The Morganza Spillway (the Spillway) is a flood control structure in Louisiana operated by the U.S. Army Corps of Engineers (USACE) and is designed to divert flood waters from the Mississippi River into the Atchafalaya basin during high water events. It has only done so twice, once in 1973 and most recently during the 2011 Mississippi River floods, to lower pressure on both upstream and downstream levees and other water control structures. The Atchafalaya basin is sparsely populated, but contains several farms and thousands of oil and gas wells that would be flooded in the event of an opening. A product of the severe floods along the Mississippi in 1927, the Spillway was one of several structures mandated by the Federal government to both mitigate future flooding and maintain the current course of the Mississippi River. These structures were designed to maintain the river at a navigable depth during normal conditions and shunt off flood water during high water conditions.

In April 2011, USACE recognized that the Mississippi floods were serious and merited consideration of opening the Spillway. As a result, they considered and modeled the flooding in four different scenarios. (For example, when the flow rate of the Mississippi approaches 1.5 million cubic feet per second at Red River Landing, Louisiana, USACE would consider opening the Spillway). On May 13, the flow rate was measured at 1.449 million cubic feet per second. Given this information, USACE weighed the flooding of the Atachafalaya basin against the potential for major flooding in Baton Rouge and New Orleans. Subsequently, on May 14, USACE lifted one of the floodgates and executed one of their planned scenarios by operating at 21 percent capacity. USACE took this action with the understanding that about 25,000 people and 11,000 permanent structures were in harm's way in the 3,000 square mile flood area.[1] On May 18, 17 gates were opened and the resulting flow rates were found to be higher than expected, which, in addition to the falling water levels, allowed USACE to reduce the number of open gates to two by June 8.

The Spillway is merely part of a larger flood control system for the Mississippi River that was designed to consider the tradeoffs between control flooding in some areas and leaving other areas unflooded. This system, the Mississippi River and Tributaries Project, is composed of four floodways, three of which were open at the same time during the 2011 floods. The tradeoff decision in the case of the Morganza Spillway involved flooding 3,000 square miles of sparsely populated agricultural land, roughly 3 million acres,[2] to save the densely populated and economically important urban areas of Baton Rouge and New Orleans.[3] Referring to that tradeoff, Colonel Ed Fleming, in charge of floodway operations for USACE, said on May 16, 2011 that "[w]e do take all the advantages and disadvantages into account. We understand the human impacts. We understand the environmental impacts. We understand the engineering impacts. And so, none of these decisions are easy."[4] The mechanism that allows USACE to make such a momentous decision for so many landowners is their acquisition of flowage easements, or, the right to flood land in the floodplain without incurring liability for damages to the flooded

(Continued on Page 28)

1. http://www.nola.com/environment/index.ssf/2011/05/morganza_floodway_opens_to_div.html.
2. http://www.americanrivers.org/newsroom/blog/sudvardy-20110513-mississippi-flood-update.html.
3. John Barry, PBS Newshour, May 11, 2011, http://www.pbs.org/newshour/bb/weather/jan-june11/floods_05-11.html/.
4. Colonel Ed Fleming, PBS Newshour, (May 16, 2011), http://www.pbs.org/newshour/bb/weather/jan-june11/flooding_05-16.html.

Hydropower*(Cont. from 20)*

and addresses the role of hydropower in meeting the world's growing water and energy needs as a clean, renewable and sustainable technology. With members active in more than 80 countries, IHA is a non-governmental, mutual association of organisations and individuals.

Dams Sector *(Cont. from 3)*

Program guidelines. It provides owners and operators and their public safety partners with the capability to identify and address security gaps, threats, issues, and concerns pertaining to their respective facilities, with a focus on information sharing and coordination during incidents. In addition, DSTET allows participants the opportunity to identify and examine the issues and challenges presented via two unique exercise scenarios provided as part of the toolbox. It is designed to allow exercise planners to tailor the details of the exercise to suit the specific needs of their individual facilities (see the *Partnerships* article on Page 7 for more information).

• The Dams Sector Analysis Tool (DSAT), currently being developed by the Dams SSA and the U.S. Army Corps of Engineers, will provide sector partners with secure access to different modules and applications covering a wide range of analytical capabilities. DSAT facilitates the identification and relative prioritization of critical facilities based on a consequence index that reflects the overall potential for combined significant impacts. In addition, it provides a reporting mechanism that can consolidate descriptive information for each facility, including operational characteristics, regional information, and relevant incidents or events. DSAT serves as the implementation platform for a conditional risk assessment methodology based on standard security configuration attributes and pre-selected attack modes, and includes a database of dam incidents as well as supporting geospatial tools.

Playing a major role in helping to publicize information and tools is the ASDSO/Sector webpage, which can be accessed through ASDSO's website (www.damsafety.org) or directly (learningservices.us/asdso/). All of the aforementioned training information and tools can be reviewed and utilized at this site. Failure or disruption of the Nation's critical infrastructure could threaten national security, result in mass casualties, weaken the economy, and damage public morale and confidence. However, through enhanced outreach, education and awareness efforts, such as those conducted by the Dams Sector, vast improvements can be made to the overall security, protection, and resilience of the Nation's dams and levees. The Dams Sector's ongoing progress is a testimonial to the effectiveness of public-private partnerships and their direct contribution to ensuring the protection and resilience of critical infrastructure. ❖

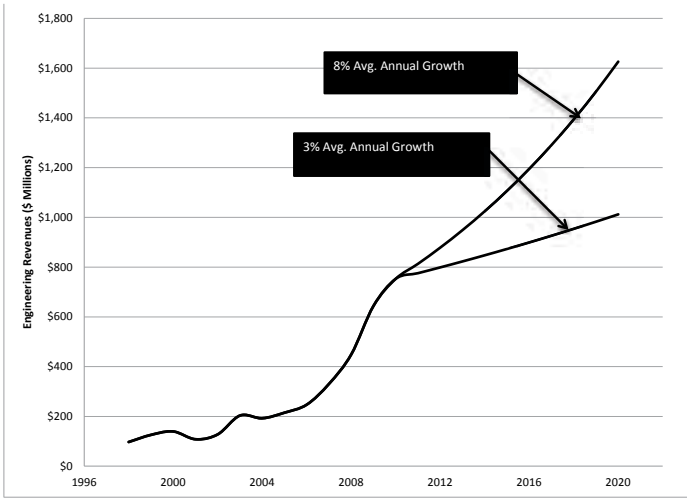
U.S. Dams Market *(Cont. from 11)*

between these two boundaries, total engineering revenues in the ENR dams and reservoirs list will be between $1.0 billion and $1.6 billion by 2020. By comparison, average annual growth rates from 1977 to 1997 in the dams market were 3.5 percent, and were 20 percent from 1998 to 2010.

ASCE and ASDSO Projections

ASCE and ASDSO have identified the number of deficient dams in the United States as well as estimated the cost to rehabilitate these dams. Current estimates place the total cost to rehabilitate the Nation's deficient dams at $50 billion. This is an increase from 2003, when the cost to rehabilitate the Nation's dams was estimated to be $36 billion. There are just over 4,400 known deficient dams in the United States and this number continues to grow rapidly. In 1999, there were approximately 1,400 dams identified as having some element of deficiency. By 2008, the number of deficient dams had increased dramatically to about 4,400. This represents an increase of over 300% in only nine years. If this trend continues, the number of deficient dams will pass 7,000 within the next five years. ❖

Figure 7: ENR Dam Revenue Growth Projections – 2010 to 2020.



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US Department of Commerce, Bureau of Economic Analysis Website - http://www.bea.gov/.

US Department of Homeland Security Website - http://www.dhs.gov/.

US Department of Labor, Bureau of Labor Statistics Website - http://www.bls.gov/.

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Partnerships *(Cont. from 7)*

resources towards developing an improved understanding of risk and blast mitigation of dams, and in ensuring the effective application of the best technologies available to address critical infrastructure protection requirements. Leveraging this progress, additional work remains to be done. The key to the future relies in the sustainment of an enduring robust public-private partnership that incorporates a balanced scheme of authorities, capacities, and resources required to get the job done. Building on the successes this partnership has enjoyed in its formative decade, the Dams Sector looks forward to continued progress in ensuring the security and resilience of our sector infrastructure and the communities it services nationwide. ❖

Global Challenges *(Cont. from 13)*

and inadequate safeguards are already a serious problem in many regions (particularly South Asia[13]) and are expected to increase under the new climate scenario.[14] Flood damages have soared in recent decades, despite hundreds of billions of dollars spent on flood control structures. Improving our ability to cope with floods requires adopting a more sophisticated set of techniques than dams and levees — the "soft path" of flood risk management, which aims to understand, adapt to, and work with the forces of nature.

"Soft-path" flood risk management seeks to reduce the damage from any size of flood and to respond to the hydrological changes caused by changing land use and river morphology.[15] Flood risk management assumes that floods will happen and that we need to find better ways of reducing their speed, size, and duration where possible. It assumes that all flood protection infrastructure can fail and that this failure for flood protection infrastructure must be planned. It is also based on an understanding that all floods are not inherently bad — and indeed that floods are essential for the health of riverine ecosystems.

Dam Safety Concerns a Window of Opportunity

Incorporating dam removal into effective dam safety programs is well-established in a number of U.S. states and in Europe.[16] Though responsible dam decommissioning can have a large initial price tag, it can add up to long-term savings through the removal of insurance liability and maintenance and repair costs, enhanced ecological and property values, and even in reduced flood damage from the restoration of wetlands and floodplains. ❖

For more information on dam safety and security, please visit: www.internationalrivers.org/en/node/492.

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13. "Pakistan Floods: Why the Fertile Indus River is so Prone to Flooding," BBC World Service Interview with Dr. Daanish Mustafa, http://www.bbc.co.uk/worldservice/news/2010/08/100818_indus_wt_sl.shtml; excerpted quotes: http://www.internationalrivers.org/node/5715.
14. P. McCully, "And The Walls Came Tumbling Down," *World Rivers Review*, (2005), http://www.internationalrivers.org/en/node/1464.
15. P. McCully, "Before the Deluge: Coping with Floods in a Changing Climate," (2007), International Rivers, http://www.internationalrivers.org/node/517.
16. Lejon, A. et al., "Conflicts Associated with Dam Removal in Sweden," *Ecology and Society* 14(2): (2009), 4. http://www.ecologyandsociety.org/vol14/iss2/art4.

Legal Insights *(Cont. from 24)*

land.

Flowage Easements

Absent legislation to the contrary, the fifth amendment of the U.S. Constitution prevents the Federal government from depriving any citizens of the use of their property without adequate compensation, what is often referred to as the "takings clause." In the case of the Spillway opening, USACE acquired easements to flood the land in the Atchafalaya basin in the 1950s when they were building the Spillway, expandeding on several easements they had bought in the 1930s and 1940s in the wake of the 1927 flood. Those easements were made possible due to the 1928 Flood Control Act,[5] which allowed USACE to acquire "flowage rights" for flood waters that would flow "by reason of diversions from the main channel of the Mississippi River."[6] USACE most frequently acquired these easements from the homeowners (though they may pursue condemnation actions in Federal court to obtain the rights); in this case, the right to store water on the lands in the flood plain. According to Tulane University Professor Richard Campanella, this is "another way of saying flooding it (the land under easement)."[7] Most importantly, the flowage easement provides the government with liability protection for any damages that occur as a result of flooding. To ensure that the right to flood without liability persists, these easements are essentially a property right held by USACE, and are therefore transferrable with the title to the property.

As the easements attach to deeds, USACE has also been sending out yearly notices, up to 1,300 homeowners per year in the Atchafalaya flood plain with flooding information. In the spring of 2011, information was also included about the potential damage to homes should the Spillway open.[8] Just as USACE had to make the tradeoff decision to open the spillway, residents of the floodplain had to consider the legal risk of being flooded in their decision to remain in the floodplain. The argument that homeowners are compensated for their assumption of the risk of living in the floodplain becomes problematic when one considers those indirectly affected by the Spillway, those who have never been compensated by an easement and who therefore do not receive the warnings issued by USACE.

The USACE responded to concerns from people in this situation, such as residents of Terrebonne and Lafourche, Louisiana, by making the distinction between natural flood areas, for which no easement was purchased and therefore no warnings received, and man-made floodways such as the Atchafalaya basin. However, these homeowners are not completely without remedy. During the 2011 floods, a situation occurred upriver at the Birds Point-New Madrid Floodway in Cairo, Illinois where a flood control structure was opened pursuant to a tradeoff decision and large amounts of agricultural land were flooded. In that case, the Federal Court of Appeals for the Eighth Circuit held that, while the failure of USACE to obtain flowage easements for every property eventually affected does not prevent the operation of the flood control system, landowners without easements had the right to seek compensation from the Federal government. This recent holding directly contradicts the blanket immunity contained in the Flood Control Act, making this issue ripe for further legislative or judicial action, particularly as natural disasters continue to dominate the headlines. ❖

5. 33 U.S.C. ch. 15.
6. Flood Control Act of 1928, Section 4.
7. Richard Campanella, (May 13, 2011), http://www.fox8live.com/news/local/story/Morganza-Spillway-opening-to-destroy-property/3WYfOtbx5kO5P5Pw9EWgXg.cspx.
8. http://www.houmatoday.com/article/20110521/articles/110529949?tc=ar.

Dam Safety *(Cont. from 16)*

CSSL to demonstrate an ALARP position may not provide a sufficiently compelling case for public safety. A more comprehensive approach is suggested whereby the owner's dam safety system forms the foundation of the safety case for a dam that is further developed through the logical case, setting out the defensive mechanisms for the identified failure modes at the dam and identifying whether those mechanisms are sufficient. ❖

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Ethiopia *(Cont. from 23)*

visit to Addis Ababa by the new Prime Minister of Egypt. Both visits dealt with the overall Nile relations and the Grand Renaissance Dam, as well as cooperation over, and benefit sharing from, the Nile River. On June 20, 2011, Sudan announced its endorsement of the project. Egypt and Sudan seem to be in dialogue with Ethiopia about the Nile and the project, and there were reports about a planned tripartite meeting to discuss the proposed dam.

Conclusion: The Challenges and Opportunities

The Grand Renaissance Dam project presents a major challenge to the Nile riparians relations, but also offers opportunities for cooperation amongst them. The filling of the reservoir could harm the interests of Egypt and Sudan if it is not done over a reasonable period of time and in close cooperation between the three countries. The huge power to be generated could benefit the three countries, as well as South Sudan, which has no power generation facilities, and Kenya, which is in desperate need for more hydropower. Indeed, Ethiopia is clearly emerging as a regional hydropower hub, and plans to be a major hydropower exporter not only to Sudan, South Sudan, and Kenya, but also to Djibouti, Egypt, and even to Yemen and Somalia, if stability were to return to those two countries. However, the Nile, like every other international basin, needs cooperation among the riparian states to realize its huge benefits. With poverty and population growth dominating the Nile basin countries, only full cooperation can help the riparian counties harness the enormous potential of the Nile to pull their population out of their poverty, misery, and under-development. ❖

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