

Chapter 22

APPLICATIONS OF OCEAN FORECAST INFORMATION FOR ECONOMIC ADVANCEMENT IN DEVELOPED AND DEVELOPING SOCIETIES

Mary Altalo

Enterprise Solutions, Science Application International Corporation, U.S.A./UK, and The London School of Economics, UK

Abstract: It is critical that the new environmental forecast information resulting from the full deployment of the Global Observing System be fully assimilated and exploited to serve the needs of societies and economies. Both developed and developing nations require the information to be “mainstreamed” into the business practices of their major industries and development programs. Providers as well as the users of the information must partner to create a “voice” to policy makers to support the global vision. Understanding the various industry drivers for the use of the information can aid in defining the optimal requirements for the design and operation of a system configured to serve societies. All segments of the economies require this information for optimal management of their operations and for informed strategic planning. Energy and water utilities, construction companies, tourism industries, the financial services sector, healthcare operations, transport, food security as well as defense all use environmental forecast information for daily operations from revenue forecasting and load management to infrastructure siting and supply chain management. The “value” of information can be determined by “industry trials” in developed as well as developing nations which demonstrate the impacts on the performance of the business, whether by increases in safety margins, enhancements in revenue generation or improvements in reliability. Cost estimates of savings are presented. The production of decision support systems for the industry from environmental information is critical to activate the information to serve societies needs. Dual sets of performance metrics, which measure the progress of both the technology deployment as well as the socioeconomic use in meeting their development goals is critical.

Keywords: Societal and business applications, weather, climate and ocean observation and information systems, decision support systems, economic impacts, industry trials, GEO, GEOSS.

1. Introduction

The purpose of this chapter is to introduce the concepts behind the application of modeled observing system information to the needs of the various economic sectors of the global business community. We will use examples from developed and developing nations to demonstrate how the information is used and the process by which it is “mainstreamed” into the business practices of industry. We will introduce concepts of marketplace dynamics and their vulnerability to environmental variability.

There are a number of ideas that will be explored in this chapter. The first is related to the “provider push” of the information—that is the “build it and they will use it” approach, versus the “user pull” whereby businesses and economies truly recognize the importance of the information and create the demand for the data and create a “voice” to policy makers to support the provision of that data. The second concept that we wish to explore is that of understanding the various industry drivers for the use of the information—that is what makes them sit up and take notice that they need the information—this may be everything from regulation to good citizenship. The third concept is to introduce the various industry segments that are in need of this information. Since there has been much attention paid to natural resource management, marine transport and oil and gas operations, this chapter will concentrate on the less frequently examined areas of the economy such as regional utilities management, construction, and tourism. The fourth concept is an introduction to the approach that we use to ascertain and “value” how information is used and how it impacts the performance of business. Here the method of an “industry trial” or “beta testing” and audit analysis are introduced. In order to illustrate the method, a number of case studies will be explored with particular emphasis on the power industry, and the tourism or leisure industry. In the case of the power industry, examples are used from developed as well as developing nations. The next concept explored is the production of decision aids for the industry and methods for linking multiple decision support tools to optimize operational performance. Finally, the need to create a sound family of business plans including financial, marketing, governance, science etc in order to “execute” the transition is demonstrated.

2. Provider “push” vs. user “pull” for observing system information

The application of scientific information gleaned from the deployment of new technologies is often difficult. Part of the problem stems from the need for “translation” between the provider and user community, but even within the academic community, the disciplines required in this transition phase

may reside in different schools within the same university. In essence, the principles used to guide the transition are in the information technology discipline which includes the field of Decision Science. These principles are taught to a large degree within the schools of management, business, and to a lesser degree within the schools of government and economics. Concepts dealt with here are those of operations management and strategic planning so critical to the overall success of any organization. Also, if environmental information is to be mainstreamed within the company “process”, organizational change may have to occur in which the structure of organizations changes to follow the information “flow”. This is the subdiscipline of Business Process Reengineering. The last issue is one of market understanding. Virtually every business is impacted by weather. Obtaining enhanced atmospheric and ocean information to improve the meteorological forecast accuracy is of highest priority. This engages inland users as well as coastal users and forces the land bound nations to invest in global earth observing as well.

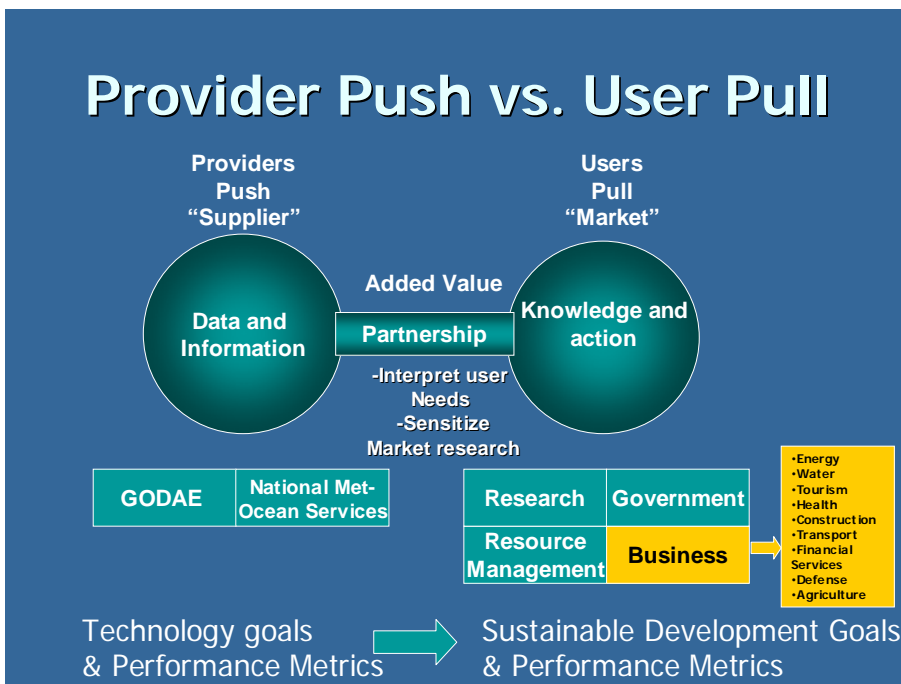


Figure 1. The polar relationship between the “provider” and the “user” of the Environmental Information. The business sectors requiring the information are shown at bottom right. Both technology as well as societal performance metrics must be applied criteria for success.

Figure 1 demonstrates the polar relationship between the data provider and the data user. Ideally, what we would like to create is a partnership between these two communities where users’ needs are interpreted and market research is tapped. GODAE, other earth observing programs within

GEOSS (Global Earth Observing System of Systems) and The National Meteorological and Hydrological Services (NMHS) are on the provider side. Normally, governments and the research community are most often thought of as the provider community. However, many of the private sector businesses also have observing systems which are increasingly being incorporated into the framework of the global observing system. The user community is a diverse one with the research, government, resource management and Business community all being considered users. The translation of the data and information into sector specific knowledge and action is the goal. Note that either “the push” or “the pull” can make this happen. The key is in the resourcing. As governments decide to endorse this effort, making the information from technology advancement relevant to their National development goals is needed. Producing and not distributing the information to societies is a serious omission resulting in widespread loss of human life and property (i.e., tsunami of December 2004).

The sustainability of each nation is tied to the development and best practices management of economies, the fair governance and protection of societies and the cultivation of a habitable environment. Only when all aspects of national well-being are addressed will Nations thrive in the Global context. Many nations of the world have set individual development goals to measure their progress. In addition, the United Nations has set global development goals, the Millennium Goals, for the alleviation of poverty, reducing spread of disease, reduction of childhood mortality, etc. The progress towards these goals needs to be continuously monitored, and in many cases, earth observations are needed to demonstrate this. Identifying and designating the earth observing system as part of a “Critical National and International Infrastructure” to safeguard and benchmark social, economic and environmental progress is a necessary step to the continuous operation of the “system of systems”. Allowing the observing system products to inform national policy, to guide market decisions, and safeguard the environment will engender the financial support of governments and businesses. This will change the focus from designing a “sustained” observing system to an observing system for sustainable development. What does this refocusing mean? It means that there needs to be new performance metrics, new awareness, new teams, new products. This is particularly true in setting the criteria for success of the observing system. At present the success is measured in how well the technology performs—that is the accuracy of the sensors, the skill of the models, the technical performance of the integrated system as a whole. These have been set by the research agenda and were very appropriate for the design, deployment and testing stage of the system. However, while these criteria need still to be in place in order to continue the refinement, upgrading, improvement and quality assurance of the technology and models, additional criteria need to be added at this stage as the information products of the system are applied to National

Development goals. Sustainability indicators such as the GRI, Moody, Standard and Poor Indices may guide in the development of these new criteria. Thus in essence we will have **dual sets of performance metrics** - one for the performance of the technology and another for the performance of the information products stemming from the research and technology.

3. The market structure for global observing system information: Who uses it, why do they use it, and what do they use it for?

The market drivers for using environmental information are varied, with safety of life and property being the overarching driver. Market economics is a major driver (i.e. profit and loss, balancing supply and demand, efficiency and cost effectiveness) where there is need to internalize the externalities of the environment to reduce the impact on operations is essential. Risk reduction at all levels of the organization is the goal and is reflected in the shareholder value and reported in annual reports of company performance. Recently there has been another driver emerging- that of sustainability, where corporate social responsibility is evaluated. The final and most compelling driver is regulation---less responsible corporations move only to this motivator.

Figure 1 also illustrates the various markets for the information from the observing systems. The user community is complex and includes the research community, governments, the business community as well as the natural resource management community (environment). The information needs for the research community have been developed extensively and, in fact, it is upon these needs that the configuration of the present observing system and modeling requirements are determined. The information requirements for the economic and government sectors are less well defined. In the government arena, much of the information produced by one agency is used by other government agencies for policy making, for the protection and regulation of national economic and social needs. Thus the major “customer” of information produced by a “research agency” is often an “applied agency”. The information needs of the business community are diverse and must be examined in detail. It is to the definition of their requirements and the understanding of how these industries use the data that much of this chapter is devoted.

There are diverse business applications for information from the global observing systems. The information used includes real time, historical and forecast information. Major applications are in the following sectors of the economy.

Energy: The energy sector has one of the greatest needs for the information in terms of both their operations and their strategic planning.

They are a sophisticated industry and thus have the capability to uptake and manipulate the environmental information to manage their risk. The needs of the oil and gas community have been examined extensively and include requirements for exploration, platform operation, product transport, pipeline laying, ship routing, refining and distribution. The power utility industry has been less examined but has critical requirements for balancing electricity loads and optimally dispatching power into the Grid. Determining fuel choice and guiding its wise use in the next decades is critical to the concept of energy security, and knowledge of regional climate information is a priority to planning of wind farms for example. Building energy control systems use “smart sensing” feedback technology to monitor the external temperature as well as pollutants to regulate heating and cooling systems.

Healthcare: In the healthcare industry, connections have been made between disease and weather and climate patterns such as drought and flood. In the ocean, red tide prediction can aid in the management of shellfish bed closures and swimming beach safety. New applications are now being made to managing the inventory supply chain as well as the scheduling of hospital and clinic emergency room staff and beds using weather event forecasting. Military bases use potential injury to personnel due to storms, icing, and earthquakes to determine base closures.

Transport: In the transport industry, ship, truck and aviation routing have long relied on the current state as well as the forecast information particularly around critical threshold temperatures (snow, ice, rain), and storm tracking. With the trend today toward the seamless integration of all forms of transport or “intermodal” transport, strategies are being developed to optimize the transport of goods and personnel in a safe, efficient and cost effective way. Using new environment forecast information is a way to mitigate unwanted delays due to “congestion” and route disruption.

Finance: The financial services sector underpins all of the other industries of the nations and has diverse needs. Today, banks are considering factors such as sea level rise, beach erosion rates, storm surge penetration and other coastal factors before approving lending for capital investment projects. Risk ratings for “environmental friendliness” are being calculated for companies, and weather derivatives are major instruments for trading and hedging.

Tourism: In the tourism industry, which is one of the largest economic sectors of the global economy, atmospheric and ocean forecasts are essential to safety and risk management in the cruise ship industry and coastal hotel industry, long term resort construction development, and facility staff and supplies scheduling. Room rate setting, revenue projections, inventory management and food service planning all rely on this information.

Water Management: Another important industry operation “at risk” from weather and ocean variables is water management where drinking

water safety, sanitation management, hydropower and irrigation all require environmental information for optimal reservoir management. New decision support for wastewater and storm water management requires the knowledge of precipitation, storm surge, winds, for optimal hedging of risk. Also, the salt water intrusion into the water table due to climate change associated variables such as sea level rise and droughts is of major concern to the coastal communities of several countries.

Food Security: The agriculture industry has long been an important user of environmental information for food and silage security and crop supply chain management. The seasonal to inter-annual information on temperature, winds, dew point and precipitation are of considerable interest to this community. Information is used for selecting seed stocks, determination of schedules for planting, irrigation, fertilization, pesticide application, harvesting, inter-modal transport logistics, crop pricing and futures trading.

Construction: The construction industry is business which, like the financial services sector, underpins all of the infrastructure needs of the other industries. Infrastructure design and siting relies heavily on metocean data for structural design codes, location and materials selection and compliance.

Defense: This industry is a diverse one including national governments as well as the private sector which serve as the civilian support arm. Force projection as well as homeland security head up the major functions. All branches of the armed services use information from the observing system for operations to gain tactical advantage to strategic planning for force readiness.

4. Organizational use of environmental information: Information needs within a company's value chain

There is an increasing tendency for businesses to be organized around their value chain or supply chain. By this we mean the functional aspects or product/service line of their company. Even national agencies and ministries are reexamining their structure and reorganizing in this fashion. The driver for this type of reorganization is that it allows accountability for each of the units in terms of how well they fulfill their function to the organization as a whole. It is important to look at this structure to determine where the environmental information being operationally produced by the met-ocean community will have the most impact in the company- that is which units are most at risk from the environment.

An example of how the value chain is reflected in the organizational structure of a company is demonstrated in Figure 2, a diagram of the organization of a major international construction company. BOVIS Lend Lease (BLL), like other leading global construction companies are

expanding their operations to include more than the construction phase of the project. This company’s value chain now spans from the financing of a project through the land development and facility design phase, through the construction phase and into new territory, the operations and maintenance of the property. These added responsibilities are increasing their need for environmental information so as to decrease their risk and vulnerability. BOVIS can minimize the financial risk to capital infrastructure investment by incorporating new environmental forecast information such as regional temperature, air quality, winds, precipitation, seismic, frost levels, etc estimates out to 30 years. This enables BLL’s investment portfolios to be compiled which have in them scientifically-based environmental predictions about the future conditions of the building site (before , during and after the construction phase), often used for insurance purposes as well. BOVIS can incorporate environmental forecast information into all phases of the construction siting, design, materials, scheduling and compliance reporting of a project. BOVIS can factor in the real time, and seasonal to inter-annual weather and climate predictions into the operations and management phase of the Business such as optimal building energy management using real-time environmental information of temperature, humidity, winds, cloud cover, pollutants for heating and cooling cost savings. Real time and short term weather forecast information can be used as well in the scheduling of staff resources as well as to “trigger” the required emergency management actions in case of a disaster.

Building Industry Value Chain Decisions Requiring Environmental Information

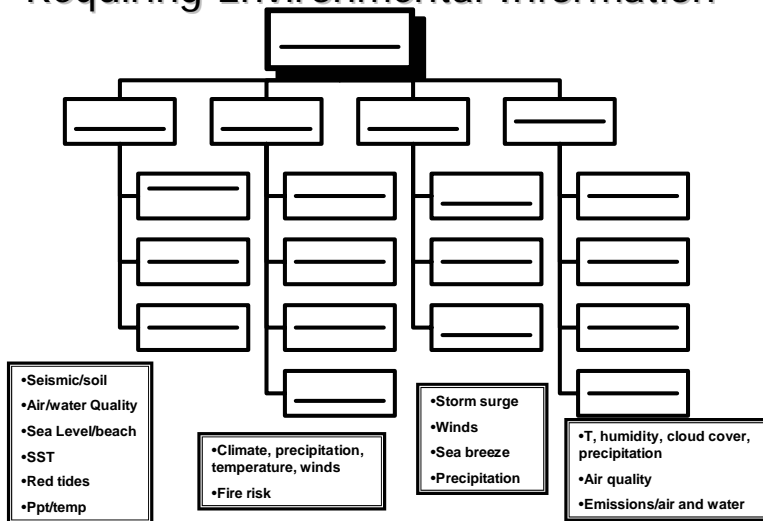


Figure 2. An example of how environmental information is assimilated into the operational decisions of the construction Value Chain of Bovis Lend Lease

The 3-6 month, local forecasts of temperature, icing, precipitation, for the advanced procurement of bulk items such as salt for freezing/snow conditions; plywood for use in hurricane conditions; fertilizer applications carried out only under specific weather conditions.

Factoring the 1 month to 1 year regional climate forecasts particularly in coastal areas allows building maintenance regimes to factor in projected impacts such as salt erosion, high winds, sand battering, and toxic mold production leading to rapid deterioration of structures, helping to set maintenance, renovation, retrofit and materials replacement schedules. This may also help mitigate potential adverse human health impacts.

5. Vulnerability of business operations to metocean processes

Optimal operations of the industry are of chief concern to the CEO and environmental impacts are noticed when they interrupt the smooth operations of the company. Thus to examine the vulnerabilities of the industries to metocean events, their impact on all management processes need to be examined. These include supply chain, inventory, fiscal, and emergency management plans and procedures. If the impacts are seen to be substantial, the normal operating procedures and possibly even the organizational structure will need to be changed. This is known as business process reengineering.

The insurer AON estimates that weather and climate have a substantial impact on over 70% of the businesses worldwide. For example in the case of weather risk, it is well documented that businesses are vulnerable and that the costs are substantial. In an analysis of annual reports of major energy corporations, much of the poor earnings performance is blamed on weather. Risk is in the form of cash flow and earnings and much of the risk comes from imperfect forecasting. In coastal regions, forecast inaccuracies are often due to an under sampling in the adjacent ocean environment.

In addition, there are critical cross cutting industry needs such as demand forecasting, emergency management and policy formulation or company governance that require the types of environmental information provided by observing systems.

6. Defining industry's information requirements

A series of research projects funded by NOAA has examined the environmental information requirements for weather climate and ocean data for major sectors of the economy. The studies spanned all time scales of operations and planning from hours to climate scale. The impacts on all

aspects of operations, planning, markets and policy making involved in the respective industry were defined. Selected results from several of those investigations are shown in Figures 3 and 4 whereby the affected operations are plotted on the timescale of forecast information needed.

In the case of the energy industry, weather, climate and ocean forecast information at all lead times is used routinely throughout the industry. The operations currently using the information most rigorously are load balancing, both for single utility and grid management, generation commitment, fuel mix choice (fossil fuel, hydro, wind), dispatch scheduling, power marketing and trading, power pricing, fuel pricing, procurement strategies, tariff scheduling, natural gas storage management, revenue projections, infrastructure siting and construction management. The most critical forecasting needs are for sub-day, 2-14 day and seasonal forecasting.

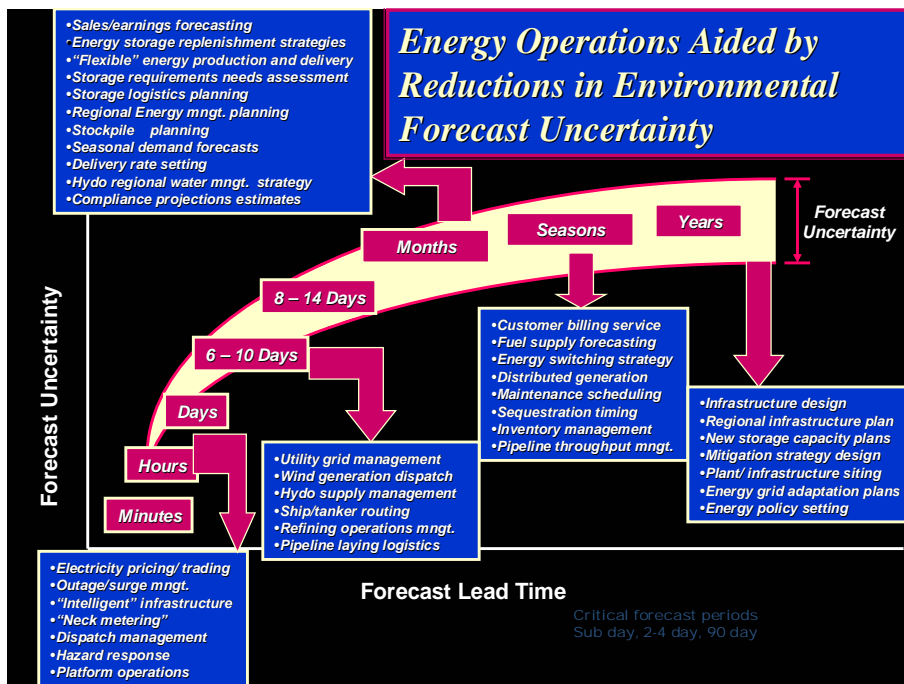


Figure 3. Requirements of the energy industry operations for improved environmental forecast data

If we examine a similar needs diagram for the water industry, several key operations that are in need of forecast data are identified. Figure 4 illustrates the needs for hydropower, drinking water, sanitation and storm water management and recreational uses. Forecast information is used at time scales from “real time” in emergency management procedures such as issuing “boil water “ orders, through seasonal forecasts for planning for

irrigation of crops, to interannual for the siting and construction of dams and reservoirs.

Interestingly enough the forecast lead time needs hold true across all sectors of the economy with transport, health, recreation and tourism, , financial services and construction industries’ operations and planning all impacted by weather and climate uncertainties.

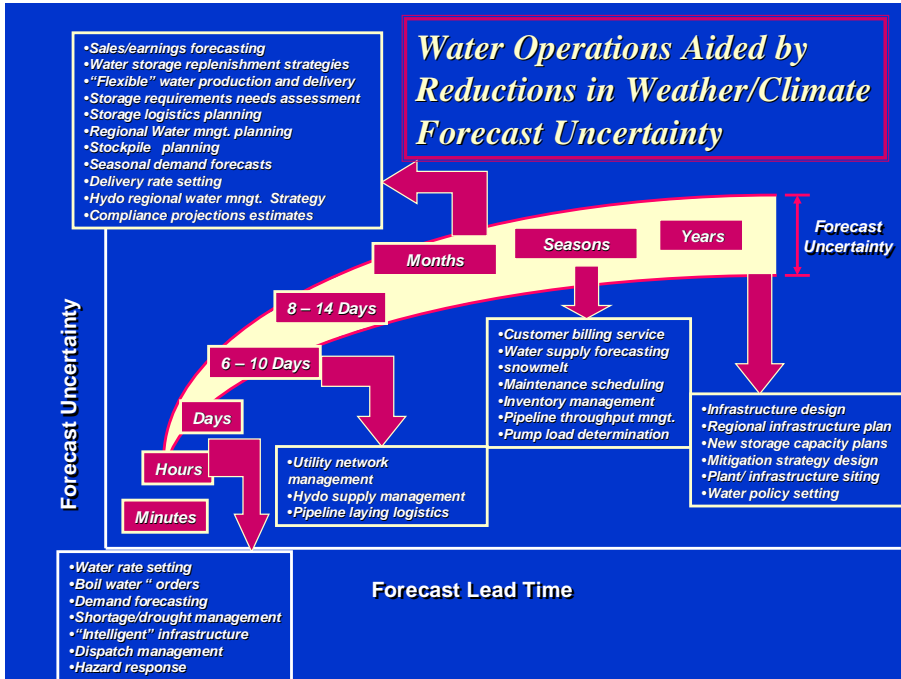


Figure 4. Environmental information forecast needs for the water industry

7. Mapping the flow of environmental information in business decisions and outcomes

Figure 5 illustrates how the environmental **data** product is transformed into **information** through the **knowledge** chain to become business information products to inform **actions** needed to effect the desired **outcome** so as to mitigate any risk imposed by the environment.

This diagram defines the operational decision process and bridges the information provider and the business user. Starting on the left, met-ocean data and /or modeled forecast products are obtained by the business user (represented by the red box) either directly through the operational agency such as the NMHS or as provided through a service provider, which may

take the information and adjust it for the operational area or other needs of the user. Many companies, recognizing the importance of getting the weather forecast “right” may actually buy “tailored” forecasts from several vendors. In some instances they average them, in others they do a weighted forecast (i.e. terrain dependent) to which they apply their own regional knowledge as to the accuracy of the data. Other analytical services will provide statistical analysis of the data in order to reduce the data error for the operational area. The “refined” forecast is now inputted into the industry “demand forecast” model, in this case load forecasting model for power demand forecasting which takes a “day ahead” temperature forecast product and uses a rolling average out to 7 days. Other inputs to this model are market dynamics, present demand, yesterday’s demand, prices and regulatory constraints, etc. The output is a demand forecast which is converted into megawatts of generation to put on the electricity grid to meet the demand. The generation scheduler then “buys” or commits the generation from the various generators to meet the need and the “dispatch” scheduler puts the power over the transmission lines to the end user. Other operational decisions which are based on the demand forecast include financial projections, power pricing, trading, etc. By effectively balancing the load (supply=demand), the desired outcome of no fines, good profit margin, increased reliability, decreased liability, etc. will follow. However, when the weather error is large and the demand forecast is substantially off leading to stresses on the system, fiscal loss, and possible threat of blackout conditions. Thus getting the weather input right is of highest concern.

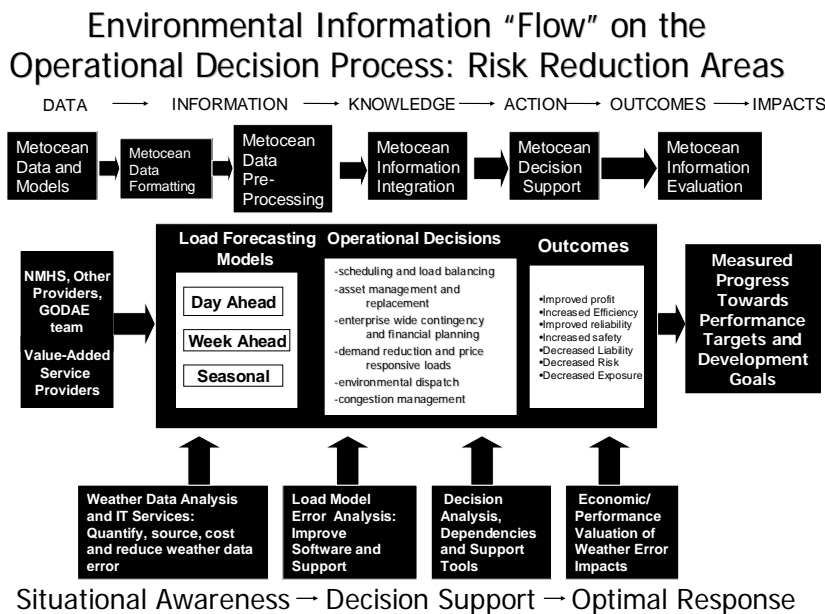


Figure 5. Environmental information “flow” in business operations.

8. Case studies from the energy industry

Weather can be a significant “tipping point” between: cost effective and non-cost effective energy infrastructure operations; reliable and unreliable operations; and, periods where emphasis is placed on either supply options or demand options. With greater uncertainty being introduced in many facets of energy supply chain delivery, load optionality and the use of weather related derivatives are becoming increasingly important.

Weather information is critical to different participants in the electric energy value chain. One example concentrates on demonstrating the value of improved forecast information to major energy operators in the Northeast U.S. and in California. To regional transmission organizations such as the New England ISO and the California ISO, both long range and short-range forecasts are critical to evaluating the ability of the system to deliver the power needed for weather sensitive loads. Each of the ISOs is responsible for 1) operating the regions built power system—a power grid of generators and high voltage transmission lines, and 2) administrating the regions wholesale electricity marketplace. The mission is to ensure a reliable power system for customers from the Northeast and California guaranteeing the equal access to electricity and transmission systems. They oversee the operation of a fair, efficient wholesale electricity market.

For local distribution utilities, such as Consolidated Edison of New York or San Diego Gas and Electric, it is critical to know about wind and ambient weather conditions so that an evaluation of the adequacy of its back up power and local distribution system substation capability during peak periods can be assessed. This information is also crucial for the major energy users, like the State University of New York system, which has the responsibility of purchasing gas and electricity for over 30 campuses.

9. Method of assigning a value to the information product: The industry trial or beta test

There are many approaches to estimating value of information from global observing systems. The first is through a cost benefit analysis approach, examples of which have been done on a number of observing systems in various countries. However, this method often underestimates the value particularly if the product is new or not recognized as useful by the customer. The second, rather different, but complementary approach is through an “Industry trial” or “Beta Test”. It is a proactive approach where a Business End Use Partner and an Information Product Provider team to run an information product “performance assessment” in real life operations. Here, the environmental information product from the observing system is inserted into an operational business model and is transformed into a business or policy decision tool (i.e. demand forecast). The business models

are run with and without the environmental information, scenarios are generated, consequences analyzed, cost factors applied and performance assessed. As the skill of the environmental forecast product increases so too does the skill of the business and policy forecast. Thus the “Demand” grows for the information product. This approach may require integrated information from ALL the observing systems elements-ocean, terrestrial, weather and climate. The “trial” approach actively engages the end user and the organizational unit in which s/he functions. The outcomes are used to guide marketplace decisions, to inform national policy and to prioritize the research and development strategies of nations.

Diagnostic Approach to Assessing Vulnerability and Risk

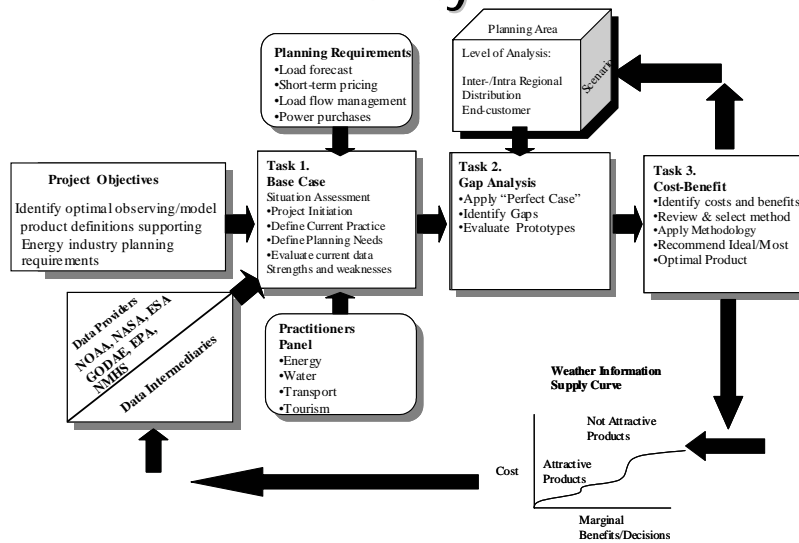
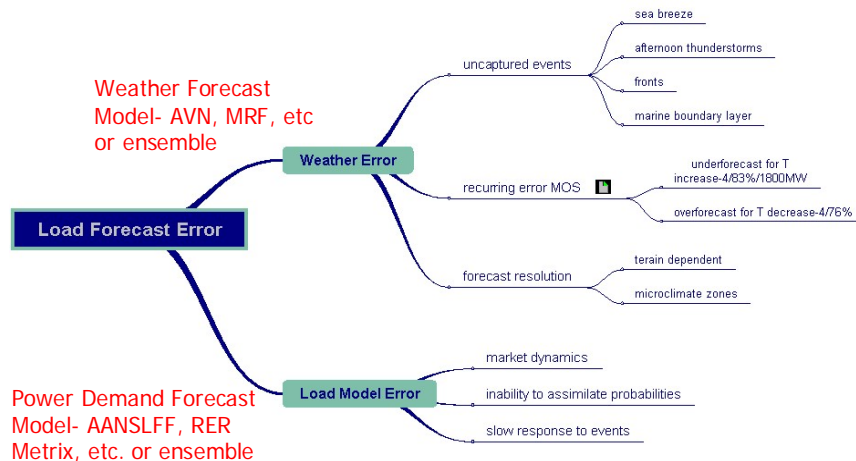


Figure 6. Diagrammatic approach to estimating the value of forecast information from the global observing system in industry operations

10. Sourcing the environmental error

Once it is established where the weather error impacts the operation, it is important to diagnose the environmental cause of the error. Figure 7 illustrates the concept of how a weather induced demand error is traced back to uncaptured sea breeze events, afternoon thunderstorms, back door fronts or fog. Only by identifying the ultimate cause of the weather error can the appropriate observing systems be enhanced to capture the information needed for the industry operations.

Electricity Demand Model Error - Neural Net Diagnostics



Skill of the Environmental Forecast Impacts the Skill of the Power Demand Forecast

Figure 7. A diagnostic approach to sourcing the electricity load forecast error to weather error

11. Cost findings

While it is beyond the scope of this paper to examine all of the cost implications of weather induced business error, a few examples will illustrate the magnitude of the impact. In general, errors in weather and climate forecasts significantly affected the operations and planning of the power industry.

Over the past years, several projects have been undertaken to evaluate the risk (Altalo et al, 2001, 2002, 2003, 2004). In a detailed study in the Northeast U.S. the demand forecasting process was shown (Figure 8) to be particularly vulnerable to unpredicted temperature fluctuations caused by seabreeze, afternoon thunderstorms, back door fronts. The Northeast Energy project 2002 estimated that the benefits of improving day ahead weather forecast accuracy by one degree F or by reducing forecasting error by 50% for days 2-7 is:

- ~\$20-25 million per year for a regional transmission authority
- ~\$1-2 million/year for a major distribution utility.

If these savings were generalized to other regional transmission organizations, and regional transmission authorities the total savings would be for the entire Northeast Region:

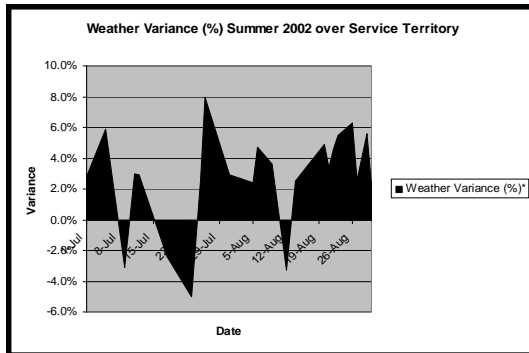
- \$100-140 million/year for ISO's. Scaling up the impact to the entire nation, the cost savings would be in the billions of dollars to the U.S.

- \$30-60 million for electric distribution companies in the Northeast. Scaled up to a National basis, the estimates would be in the 100's of millions.

Furthermore, capturing the “events” such as seabreeze, fronts, “pop-up” afternoon thunderstorms etc., on top of this will yield significantly higher savings (10's millions/day regionally).

Urban Utility Case Study

Findings 1: Significant load error due to weather



Most utilities calculate weather error in MW as well as percentage of variance of the load. Analysis indicates that on some days, variance in the load forecast in MW may be solely due to weather error. This appears to be from events or unmodeled mesoscale features such as back door fronts, sea breeze and afternoon thunderstorms. The cost of such events can be up to \$10M/day in wasted generation.

Figure 8. Impact of weather error on electricity load error

In another study on the West Coast of the U.S. significant error in the day ahead temperature forecasts can lead to a significant error in the electricity demand forecast resulting in high financial consequences, in this case several million dollar loss per day, as well as grid instability. Figure 9 illustrates the impact of one such temperature error on the load error of the grid operator, nearly bringing the system to instability

In an additional example, a west coast sea breeze phenomenon known as the Delta Breeze contributes strongly to the load forecast error for the same grid operator as shown in Figure 10. To mitigate these effects, new information from operational observing system from buoys, radar, satellite, needs to be brought in and captured in the numerical prediction models for that area. In many cases, the weather prediction models need to be refined through the use enhanced modeling techniques such as ensemble based forecasting which may yield significant improvement in forecast accuracy and have been shown to reduce overall summer peak electricity error (Smith et al 2005, Altalo and Smith 2004). In addition, the utility load forecast models must be often be reconfigured to accept the new data or the probabilistic information from ensembles. This is where a partnership comes in.

Retrospective Analysis: Relationship of Coastal Weather Uncertainty and Cost

- Underforecast T Case Study . Weather forecast error of 4% leading to a demand forecast error of nearly 5,000MW leading Cal ISO Weather Forecast Error and Potential Cost \$4-7M/day

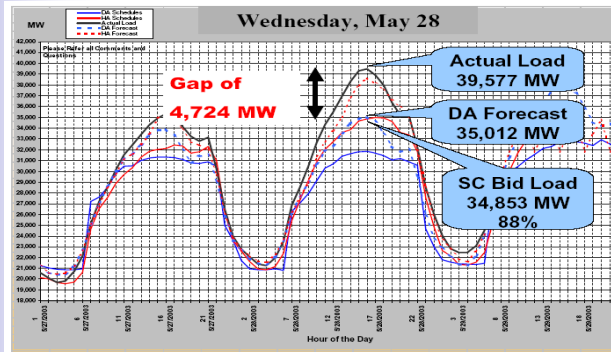


Figure 9. Temperature underforecast and impact on bid load. The shortfall of nearly 5000 MW of generation caused the ISO to buy costly “on spot” power.

Cal ISO Mean Daily Forecast Error

- Delta breeze and weather/load forecast errors contribute to major errors in prediction of Delta Breeze effects.
- Delta breeze is defined as the conditions when the wind speed is > 12 knots and the direction is between 190 degrees and 280 degrees.
- Delta Breeze can change load by 500MW
- Direct Costs: 250k per breeze day; 40 events per year
- An over forecast problem

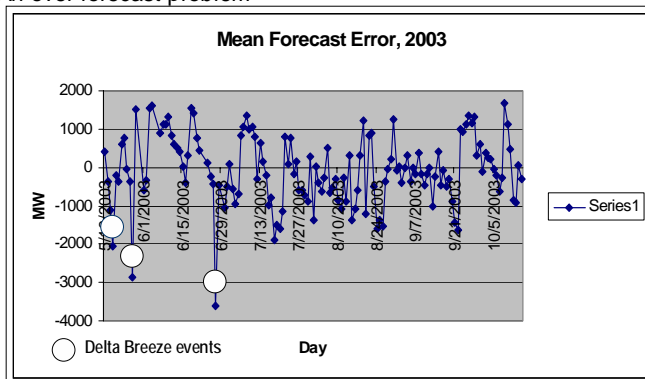


Figure 10. California sea breeze impact on load forecast error and resultant fiscal loss

Requirements

Environmental Information in the Power Value Chain

Energy Operations	Fuel choice	Generation	Pricing	Transmission	Transport (gas)	Distribution	Energy Procurement	Demand Side management
Environmental Dependency								
Sea breeze						x		x
Offshore wind prediction		x						
Fog						x		x
Back Door fronts						x		
Sea/lake Level/wave height	x	x			x			
Air Quality		x						
Microclimates						x		
Precipitation Forecasts						x	x	x
Radiation						x		x
Water Temperature		x						
Air Temperature			x	x	x	x	x	x

Table 1. An example of the requirements of the power value chain for information from the Global Observing System

Studies such as these lead to the definition of a set of requirements by the industry for observing system information as shown in Table 1. Real time winds, fog, dew point, cloud cover as well as temperature forecasts are needed to help meet operational as well as strategic planning needs. Observation systems can and need to be configured with dual goal of meeting research objectives and satisfying national needs

12. The enhanced value of the environmental forecast product to developing nations

Developing nations, as well as developed nations are in critical need of the weather, climate and ocean forecast information that observing systems can provide for the optimal management and planning of their business interests. This applies across all sectors but is particularly important in the infrastructure planning of roads, water, electricity, mining, agriculture and

health. In regions where hydropower makes up significant fraction of electrical generation capacity, incorporating climate-induced weather information into the daily operations of the facility could head off disasters.

An example is taken from a study conducted in Ethiopia with EEPCo (Ethiopian Electric Power Company) which is the public agency responsible for generation, transmission, and distribution. In this country, 97% of electrical generation is from hydropower produced by Koka Dam, with major use by heavy industry such as cement, metal, and sugar. Energy generation averages growth 10%/year. There is large scale inter-annual variability of rainfall in this country leading to periods of droughts and floods. Seasonal to inter-annual predictions offer great benefits if hydrological indicators are used for planning by the industry. The value of the advanced environmental information can be used as the basis of a risk analysis to mitigate flash flood hazards and identify periods of water scarcity. There is a need as well to incorporate surface variables (precipitation and temperature) into hydrological forecasts. Information on the timing, location and duration of flash floods is used for water releasing schemes from dams by Ministry of Water Resources; and, as dam capacity is impacted by the erosion in a basin, such information is of value to the construction engineers.

During drought, power rationing leads to major revenue loss. In a study conducted under the IRI program, the linkage effect of power production and customer revenue loss was examined and determined to be approximately \$8M, enough to destabilize local economies. From these types of studies, it was recommended that EEPCo must include seasonal forecasts into its long term plan. It was also recommended that they produce power demand scenarios based on seasonal rainfall outlooks. For the “provider” community, it was recommended that the development of future models include hydrological parameters in addition to meteorological variables, and that they combine variability of rainfall, complex topography and behavior of rainfall on sub grid level. The skill score of climate forecasts needs to be improved as well as performance metrics set for the improvement in business operations and planning.

In another IRI benchmarking study with Kenya Power and Lighting Company (KPLC) and KenGen, it was determined that drought-induced rationing decreased production to 40% and they had to secure an emergency power credit of \$72M to purchase fuel since there were no sources of fossil fuel internal to the country. In addition, to help mitigate the crisis, the World Bank granted \$47M to import and operate generators. The economic losses from rationing and power failure were estimated at \$2M/day and KPLC lost \$20M /6 months with expenditure of \$141M for fuel. The effect was 12 hr. power rationing which translated to massive layoffs. Seventy percent of the manufacturing firms not willing to increase investment in Kenya if power reliability issues were not addressed. In this case, the energy crisis loss to

economy was \$100M/month. Drought was one of the contributing factors to poor reservoir management with deforestation, environmental degradation, poor agriculture practices in catchment areas contributing as well. The result was low water levels and under performance of turbines, cascade operations sustained thru low level outlet releases. The recommendations to KPLG and the government from this study included incorporating seasonal forecasts into its long term plan for hydropower management. For the prediction community there is a need to increase rainfall prediction tools, and to incorporate soil and evaporation for calculation of water losses.

13. Entraining environmental information in decision support tools

One of the biggest challenges to both the provider community as well as the business community is to turn an environmental forecast into a business decision support tool. From the user point of view, the high level goal of the entire process is to “morph” the environmental information into something that the industry can use– or “Turning a metocean forecast into a business forecast” to enhance decision making. The steps are straightforward and consist of

1. Improving the metocean product to deliver the information on an operational basis and in a format usable by the business community;
2. Establishing the “relationships” or dependencies between the environmental event and the business effect (i.e. the power curve of wind speed and electricity generation)
3. Turning that relational information into a predictive business tool
4. Using the predictive tool to formulate an action plan

Figure 11 illustrates how appropriately designed decision support tools (this one designed for MEMA, the Maryland Emergency Management Agency) can “pull in” a hurricane track forecast, link it with a critical infrastructure list to feed into a consequence risk assessment prediction toolset (CATS) that is capable of informing decisions on which transmission lines to restore (Expert Grid) in order to ensure the hospitals and shelters in the disaster area have power. This method creates the situational awareness to map the “at-risk” critical infrastructure with reliable environmental forecasts to activate disaster management action plans. The work helps emergency managers to identify, prioritize and coordinate the protection of critical infrastructure, and can be integrated into comprehensive emergency management systems. Ensuring that the Global Observing system infrastructure is also on the critical infrastructure lists of nations is essential to national security.

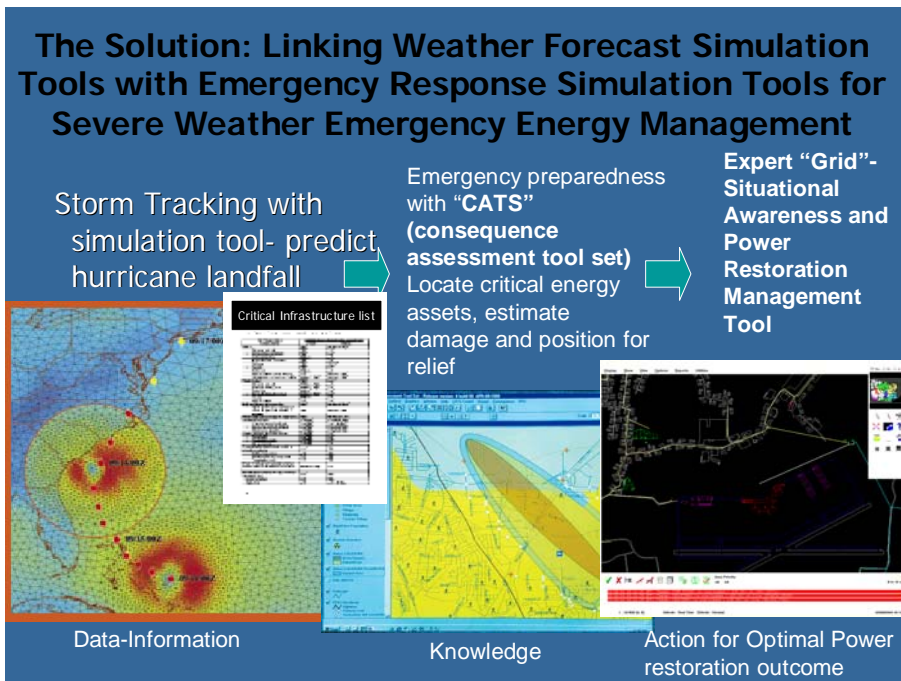


Figure 11. Linking environmental forecast information with decision support tool sets and critical infrastructure needs lists contributes to the successful deployment of disaster relief emergency operations, in this case for the restoration of essential services (power) to hospitals

14. Business case considerations

While it is important to stress the scientific design, observational strategy, data assimilation and distribution scheme and delivery mechanisms to users, it is of equal importance to consider the Business plans for the overall operation and management of such a system. Businesses will not incorporate the environmental information into their decision making if they think that the information may not be sustained. Thus there is a pressing need to demonstrate that the information will be available long term or operationally. A credible business plan for the long term financial strategy to sustain the observing system must be developed and may include traditional funding sources such as science and technology agencies as well as less conventional sources such as more applied agencies and ministries, business councils, the private sector and even venture capital. New studies showing the changing nature of R&D funding (ie. Mullin), show that many projects are focusing on this topic. Legacy planning must start now and all of the potential investment partners must be invited to the table in the beginning. There are many models in existence to determine the appropriate course of action. Technology transition and commercialization strategies may shed

some light on the issue. Also the changing roles of investment strategies with a many financial backers can be taken under consideration.

15. Summary and conclusions

The major conclusions of this chapter are that: GODAE provides situational awareness to enable optimal operational management, strategic planning and policy support to the business community thus enhancing the development of national economies to meet their individual development goals. Retrospective analysis of the dependencies of metocean events with business performance can help set priorities for research with potentially high payoff to society. "Beta testing" of new environmental information products through an industry trials approach can lead to the rigorous estimation of the costs mitigated with the incorporation of the new environmental forecast information. It must be realized that the impact of new forecast information may be highest in developing nations. Institutionalizing the new information in a decision support tool is critical, and, developing a long term business strategy to financially sustain the information product will ensure the success of the program.

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