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REDUCING URBAN AND INDUSTRIAL POLLUTION IN CHILE

The Chile Environmental Pollution Prevention Project demonstrated that industrial firms can save money while reducing pollution. But the effort had mixed results: it lacked an institutional base to sustain and replicate benefits, and missing was sufficient regulatory muscle (fines and penalties) to encourage pollution prevention.

SUMMARY

In Chile's capital of Santiago, the summer sun rises over a hazy, smog-filled sky. The sky darkens as the day progresses and often turns a light brown. In winter, air quality is even worse, and visibility drops sharply. A ring of mountains and thermal inversions trap pollution in a choking cloud over the city. But the mountains and air currents are not the whole problem. Twenty years ago the air was relatively clean. That was before economic growth accelerated sharply. A rapid increase in industrial production and a major increase in truck, bus, and automobile traffic are all pumping pollutants into the air. The result is a high level of respiratory problems, sickness, and premature death.

Air pollution is a clearly visible health problem. An unseen and possibly greater problem exists with water pollution. Industry sends its wastes into rivers and municipal sewage systems. These often contain hazardous chemicals and metals (lead, chrome, nickel, copper) that cause neurological damage and cancer. Although municipal sewage systems exist in all major Chilean cities, only 5 to 15 percent of sewage is actually treated. The rest is pumped raw into rivers or the ocean. Solid industrial waste, often containing hazardous chemicals, is sent to landfills, where it may percolate into the aquifer and drinking water. High bacterial levels in drinking water cause diarrheal diseases. Waterborne chemicals and heavy metals are creating longer term health problems, which will be seen in

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increased morbidity and mortality in the near future.

In 1991 USAID launched the Environmental Pollution Prevention Project. EP3 was designed to reduce pollution at its source by introducing cleaner industrial production processes, and reducing and reclaiming industrial waste. The improved processes were designed to reduce pollution while saving money for industrial firms.

In April 2000, a three-man team from USAID's Center for Development Information and Evaluation (CDIE) completed an assessment of EP3. It found a number of achievements.

For example, nearly 2,500 people received training in industrial-pollution prevention, and a cadre of private sector pollution engineering consultants had been created. EP3 completed 26 Pollution Prevention Diagnostic Assessments at individual factories. The PPDAs showed it was possible to save money while reducing pollution. The assessment recommendations required a one-time investment of $1.4 million by the industrial firms—but that investment generated annual savings of $1.9 million. Savings continued every year for many of the companies. Pollution was reduced by 32 percent.

Although the project reduced pollution and generated high rates of return, the CDIE evaluation found several problems. The project failed to institutionalize the effort, so once USAID funding ended, both sustainability and replication lapsed. The effort also faltered because Chile lacked effective environmental regulations. Without the pressure of environmental fines, many companies were reluctant to invest in pollution prevention.

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BACKGROUND

A civilian government took over from the military regime of Gen. Augusto Pinochet in March 1990, ending years of political oppression. Political change and the emergence of democracy were dramatic. There was also a major change on the environmental front. During the years of military rule, the government had little interest in the environment. Environmental regulations and controls were almost nonexistent. Industrial investment and production were encouraged, with hardly a thought given to the impact of rapidly rising pollution.

With the return of democracy, things changed. Just as before, the people can see the bad air and taste the bad water. But now they realize the government can do something about it. They have pressured the government, and it has responded. The National Congress passed an initial environmental law in 1993, and other laws and regulations were put in place in later years. Even with new environmental regulations, environmental quality did not improve because of rapid economic growth. Real gross domestic product (GDP) growth averaged a remarkable 7 percent a year from 1991 through 1997. With strong growth in output, pollution increased at an even faster pace.

Benefits, Drawbacks To Test-Case Project

The Environmental Pollution Prevention Project (EP3) in Chile was USAID's first foray in a nine-country program to abate pollution. As the first undertaking, the Chile project identified problems and alternative solutions. But being the test case does have drawbacks. Mistakes and problems provide lessons for other country programs, but the Chile project bears the learning costs. In addition, it had a short project life—only three years. It started in September 1993, slowly geared up, moved into rapid implementation, and then closed down in October 1996, without any follow-on program. That was because Chile graduated from USAID assistance in 1996, bringing EP3 to an end.

The project came to Chile when environmental concerns were just surfacing. The few pollution controls that existed addressed “end of pipe” treatment—reducing pollution at the smokestack or drainpipe. A different approach is to prevent or reduce pollution at its source by improving the production process. If the production process is more resource efficient, it produces less waste. EP3 used this approach, also referred to as waste minimization or clean production. Companies that adopted resource-efficient production processes were able to reduce their costs while reducing environmental damage and improving public health.

EP3 was designed to reduce pollution at its source by changing industrial production processes and reducing and reclaiming industrial waste. In the latter method, water, dyes, and chemicals are recovered and recycled back into the production process rather than being flushed down the drain. Electricity, steam, and raw materials are used more efficiently, and improved process controls reduce waste and improve product quality.

Importance of the Bottom Line

To prevent pollution at its source, industrial firms must be convinced that pollution prevention pays—that it is financially beneficial. Industrial firms do not wish to harm the environment, but they are in business to make a profit. They want to avoid fines and the prospect of being shut down for causing excessive pollution. But they also are motivated by positive incentives. If low-cost, environmentally sensitive investments will reduce costs and increase profits, firms may take action. The motivation is profit, but the environment simultaneously benefits. That was the EP3 strategy.

When EP3 was being designed in 1992 the Chilean government lacked environmental laws, regulations, and institutions. In many countries manufacturers are encouraged to reduce pollution by a carrot-and-stick approach. The carrot is cost savings; the stick is the threat of fines or a plant shutdown. In Chile such punitive measures did not exist. USAID decided to go the private sector route and to concentrate on cost savings for firms, rather than attempting to meet environmental regulations, which were not yet in place. In contrast with some other environmental projects, EP3 was not implemented directly with a Chilean government agency.

PROGRAM ELEMENTS

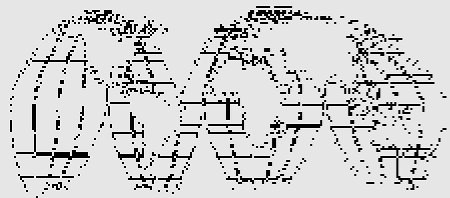
EP3 Chile concentrated on technical assistance and training to build knowledge and awareness of pollution prevention and to encourage industry to adopt appropriate technology. It did little in policy reform, regulation, or institutional development.

Education and Awareness

The project faced a difficult task when launched in 1993. Environmental regulations were virtually nonexistent; those that did exist were woefully out of date (one of the main laws, the Law on Liquids, was written in 1916). What few antipollution measures existed were directed at end-of-pipe treatments. The project took on the task of educating industry, government, academia, local consultants, and nongovernmental organizations (NGOs) on a new concept: the value of pollution prevention. Absent pollution regulations, EP3 could not count on the threat of fines as a motivational tool. The project had to convince industry that it would save money through pollution prevention. It also had to train local environmental consultants to implement the project and to carry it on after USAID assistance ended.

Training and outreach to transfer industrial pollution prevention and environmental management skills was a central part of EP3. Initially, it concentrated on selected industrial groups to build interest in pollution prevention and to identify opportunities for environmental audits. A second stage was aimed at specific sector training to develop interest among a wide range of industries: textiles, tanning, mining, printing, chemicals, hospitals, food processing. A third stage was based on thematic training, outreach, and awareness building to disseminate lessons learned and to replicate the experiences among other industrial groups, supporting governmental institutions, academia, and NGOs.

Some 2,500 people were trained in industrial pollution prevention concepts, diagnostic methods, and the tools and skills needed by pollution consultants. There were 1,061 from industry, 752 from universities, 309 from government, 252 from NGOs, and 123 from environmental consulting firms. Training local trainers helped develop local capacity to extend the training program. A continuing benefit has been the emergence of a dynamic and viable consulting industry. Consultants are generally well respected by industry and are continuing to work on issues in pollution prevention engineering. While EP3 increased the *supply* of pollution engineers, there were problems on the other side: a lack of *demand* for these specialists. Without the threat of fines and penalties, companies are slow to take action to reduce pollution.



"A continuing benefit has been the emergence of a dynamic and viable environmental consulting industry. Consultants are generally well respected by industry and are continuing to work on issues in pollution prevention engineering."

When EP3 was initiated, pollution prevention was not a well-known concept in Chile. While it is hard to draw a direct causal linkage between the project's knowledge and awareness efforts and pollution prevention, it is clear that the concept is now fully accepted by industry and government. EP3 helped stimulate the change through the preventive message it preached and the people it trained.

Technological Change And Assistance To Industry

Pollution Prevention Diagnostic Assessments, which recommended specific production process changes, were completed at individual factories. USAID funded the costs of the audits. The costs of pollution prevention investments were the responsibility of the factory owner.

Recommended technologies ranged from low-cost and no-cost housekeeping, maintenance, and process changes (such as recycling rinse water or recovering waste materials) to major capital investments (such as new production equipment). Government financial incentives such as subsidies, tax relief, or accelerated depreciation were not available. The attractiveness of any measure depended solely on its potential to increase short-term operating profits.

Acceptance of recommended changes averaged 40 percent, but it varied greatly among firms. Some accepted nearly all recommendations; others adopted only a few. The key to acceptance was the quality and suitability of the audit recommendations, the size of the investment, the cost–benefit ratio of the investment, and the skill and business savvy of the owner and manager. Surprisingly, some factory owners were reluctant to implement changes even when cost savings and all other indicators were strongly positive. This may have been due to an unwillingness to experiment in an already marginal enterprise, or the firm was unsure about the course of future environmental regulations.

A typical case of a small, marginal enterprise was an electroplating factory that faced steadily declining sales because it had lost a major production contract and did not adjust to new market demands. It was running down its equipment and slowly going out of business.

Implementation was further slowed because in many instances it is less expensive to pay disposal fees to the sewage utility or landfills than to install clean production technologies. That is changing, though, with increased fees for landfill disposal, special processing fees for hazardous or toxic wastes, and increased frequency and size of fines for noncompliance with sewage discharge standards.

EP3 did not consider end-of pipe measures or the effects of upstream production changes. This is unfortunate since end-of-pipe technologies may be adversely affected or need to be modified as a result of changes in the waste stream caused by pollution prevention measures. Further, in most processes (regardless of how clean or efficient) there will still be wastes to recycle, reclaim, treat, or dispose of.

Regarding end-of-pipe measures, many industries in Chile have invested in pollution-control equipment such as flares, filters, baghouses, venturi scrubbers, and effluent neutralization systems. These systems must be considered and optimized as part of an integrated approach to reducing pollution. Cross-media effects must also be considered. Solving a water-quality problem may create air-quality or solid-waste-disposal problems. For example, collecting organic vapors from the smokestack by a wet scrubber produces a liquid waste that must be reintroduced to the pollution reduction process or disposed of. Thus, one problem may simply be traded for another—but not identified in a project such as EP3 if its intent is exclusively to prevent pollution.

What is needed is life-cycle analysis, an integrated approach that considers the industrial process from start to finish as well as product end use. The approach considers process inputs, cost-effective pollution prevention measures, the sometimes necessary end-of-pipe applications, and disposal or recycling of the product after it is no longer useful. The desired result is a cost-effective net reduction in pollutants.

Economic Policies

Key Chilean government policy managers were trained at the University of Chicago, noted for economist Milton Friedman and his free-market approach to economic development. The Chicago-trained economists turned Chile into a free-market model. Chile relies almost completely on private enterprise and free markets to drive its economy. Government price and market controls, incentives, and subsidies are almost nonexistent.

World market prices prevail for virtually all industrial inputs. The economy is nearly free of price distortions or subsidies that would encourage environmentally harmful activities. While almost all other countries subsidize pollution control, in Chile pollution prevention subsidies, concessional loans, or investment credits do not exist. Indeed, they are dismissed by both government and industry as bad policy.

For industrial wastewater there is a pollution prevention incentive. The Santiago water and sewage utility (a private company) imposes water charges based on the volume and concentration of wastes in the industrial effluent. There are also upper limits on major pollutants. Companies pay the utility for the cost of receiving their waste—a strong incentive to reduce water pollution.

The CDIE assessment team visited 18 companies, 10 that had received EP3 assistance and, for comparison, 8 that had not. Basically, the economic foundations of EP3 were sound; the market provided the financial incentives necessary for pollution prevention to succeed. The project showed that many companies were motivated to undertake preventive actions to save money from recycling and from increases in efficiency, reduced waste, reduced input costs, and improved product quality. They were also motivated by the prospect of avoiding the costs associated with excess waste disposal. Several factors influenced pollution prevention investments:

1. Companies that were successful at preventing pollution had physical plants that were clean and well organized. Management was aware of production costs, was developing new products, was interested in innovations, and was aware of what the competition was doing. In contrast, dirty firms had a chaotic factory layout and were not on top of costs or new product developments. Willingness to adopt clean production measures is correlated with a history of good management practices. The skillful owners and managers are most likely to have a better and more productive operation and clean production, and pollution prevention is a natural part of an efficient operation.

2. Managers who expected the cost of waste disposal to increase were making pollution prevention investments as a means to avoid future problems. Anticipated cost increases are due to stricter government regulation of air pollution or expected increases in the cost of wastewater treatment or landfill disposal.

3. The adoption of pollution prevention technologies appears to be accepted when businessmen believe that costs of noncompliance will be equitably imposed on others in the same business. In other words, action is conditional on there being no environmental “free riders” who might gain a competitive advantage. That supports an industrywide approach to the introduction of pollution prevention technologies and transparent environmental regulations.

4. Most businesses that participated in EP3 were owner-managed small or medium-size firms. Being frugal, managers were reluctant to make long-term investments and generally went with low- or no-cost pollution prevention measures. These were all internally financed. Of the EP3 participants interviewed by the evaluation team, none cited lack of finance as a barrier to adopting pollution prevention measures.

Government Regulations And Standards

In 1994 the General Environmental Guidelines Law created a legal framework for environmental management. It formally created the National Commission on the Environment (Conama, the Chilean environmental protection agency), which was charged with coordinating the environmental units of all ministries. Zoning is another way to regulate pollution. Industry wants to be in metro Santiago to have access to labor, inputs, and markets. The government wants the most polluting industries to locate elsewhere and has established penalties to encourage them to move. Several of the small and medium-size factories that participated in EP3 are in residential areas. Governmental zoning regulations restrict new investments by such firms. They can stay where they are but cannot expand production. In the case of a tannery, it had to use cleaner technologies and a less polluting process. It also had to move the dirtiest part of production outside Santiago.

EP3 was by design an industry-oriented program with little emphasis on governmental policy or regulatory development. EP3 worked on the supply side: helping create the technology and skilled manpower and demonstrating the financial savings that firms could realize while reducing pollution. But the availability of environmental audits, cost-saving technology, and trained environmental engineers was not enough. As EP3 progressed, it became apparent that even though the cost–benefit ratio for pollution prevention measures was strong, and environmental engineers were trained and ready to help firms, the demand side was weak. Regulations were needed to spur industry interest. Without the threat of fines and penalties, industrial demand for pollution control measures was limited.

Chile's environmental regulations were under development and lagging behind EP3. Little of the information developed under EP3 was used by the government as it developed its regulatory framework. The need to develop policies and regulations, to involve government, and to broadly disseminate results should have been recognized early in the EP3/Chile program. Failure to take those actions reduced program effectiveness.

Institution Building

Conama became fully effective after EP3 ended in 1996. During implementation, EP3 concentrated almost entirely on the private sector. It did little to institutionalize EP3 lessons in the emerging Chilean environmental agencies. This is not to say that the concepts of pollution prevention, waste minimization, or clean production were not well known inside government circles. They were. What is important is that few current government officials were aware of EP3. The assessment team found almost no linkage between EP3 and current environmental policies and institutional structures.

Now there are several dozen government, NGO, and private sector organizations dealing with the environment. During the time of EP3, only a few were in place. In one sense EP3 was ahead of its time, and the institutions were not ready to take on pollution problems. Some might argue, on the one hand, that the inchoate nature of environmental institutions in Chile during EP3 made it difficult to identify which institutions would develop and become effective. Efforts to identify institutions might have dissipated EP3 technical efforts that were raising awareness of pollution prevention in the private sector. Others might argue, on the other hand, that new institutions can often provide new opportunities to exercise a positive influence. A more proactive effort to engage government policymakers might have reaped benefits.

IMPACT

The real test of any aid project is its impact—what the benefits were and how they were achieved. The *cost* of achieving impact is also important. For pollution prevention activities, this includes financial costs and benefits to industrial firms and environmental and health benefits to the general population.

Economic and Financial Impact

The concept underlying pollution prevention is to generate less waste at the end of the pipe. Any in-plant practice that reduces or eliminates the amount or toxicity of pollutants before they enter the waste stream will generate environmental benefits and improve the health and safety of employees. Just as important, the pollution prevention process imparts financial benefits to the factory.

Financial returns are generated in three ways: 1) by lowering operating or input costs (through recovery of raw materials or increased efficiency in the use of energy, water, or steam); 2) by using a cleaner production process (reducing fees and penalties for contaminants discharged); and 3) through improved process efficiency (either through increased output or by recycling or recovering what was formerly waste). In addition, there are financial benefits if the processes result in increases in product quality, fewer rejects, greater productivity of workers, less downtime from equipment repair, or less downtime from safer operations.

Twenty-six Pollution Prevention Diagnostic Assessments were completed covering 7 industrial sectors: tannery (3), textile (3), printing (4), food processing (4), hospital (2), mining (4), and chemical (6). Approximately 40 percent of the EP3 recommendations were implemented. Those recommendations resulted in estimated total annual savings of $1.9 million against total one-time investments by industries of $1.4 million. The pollution prevention investment costs were recovered in just nine months. Pollution was reduced by 32 percent, and annual water savings were 1.4 million cubic meters. The average annual saving per facility was $72,000, with an average one-time investment of $53,000. While the savings were important to all the factories, there were some big winners. Mining and food processing generated 91 percent of the investments and 91 percent of the savings.

Site visits by the evaluation team to one third of EP3 participating firms found that they were interested in no- or low-cost investment, rather than higher cost investments, even when the higher cost investments had much higher rates of return. This was because of their 1) small budgets, 2) short planning and accounting horizons, 3) unwillingness to move away from time-tested patterns of production or lack of knowledge about new production technologies, 4) lack of management resources to supervise new procedures, and 5) high risk aversion.

The greatest financial returns accrued to larger companies. Those firms were willing to undertake higher cost investments. Many had linkages to or were owned by foreign firms that encouraged pollution prevention. Other successful participants, such as a tannery and a textile factory, have moved into production for export.

What distinguishes those companies is not that they readily implemented most of the EP3 recommendations but that they had the financial capacity to shift their production either into a more diverse product line or invest in newer, more productive technologies. A weak market and increased local and international competition led to some of the smaller firms' abandoning pollution prevention measures previously adopted or limiting production so severely that recommended pollution prevention measures were no longer relevant.

Table 1 summarizes costs and benefits. Typical savings resulted from reductions in chemical or energy use, improvements in raw-material recovery, improved product quality, and productive use of waste materials.

Average annual financial returns were conservatively estimated at 5 to 20 percent by owners and plant managers of the one third of the participating companies examined by the evaluation team. Masked in these averages, though, are some postproject cost savings resulting from waste management early in the industrial process and not at the end of pipe. Decisions to introduce new methods of waste recovery at the dairy resulted in avoided costs of about $1 million by eliminating the need for construction of a new primary sewage treatment facility.

As an example of cumulative financial savings, one of the tanneries reported that it reduced water use by 40 percent, for a saving of $4,000 a year; reducing fuel use saved $2,000 a year, and the tannery saved an additional $30,000 a year by decreasing losses of chrome in wastewater to 4 percent from 40 percent. Not included in the EP3 recommendations was an enzyme process for biological treatment of hides in lieu of increased use of chemical washing. Savings were $3,000 a year with significant decreases in biochemical oxygen demand in the waste stream. Moreover, clean production improved

Table 1. Costs and Benefits From Recommended Pollution Prevention Measures

Sector	No. of Firms	Percent of Options Imple-mented	Percent of Pollution Reduction	Annual Water Savings (m^3)	Investment Size (US$)		Annual Saving	
					Average per Facility	Total	Average per Facility	Total
Chemical	6	57	35	168,140	3,441	20,650	6,856	41,136
Food	4	44	22	295,035	78,396	313,585	127,740	510,960
Hospitals	2	37	40	0	n.a.	n.a.	n.a.	n.a.
Mining	4	26	23	757,440	237,500	950,000	300,445	1,201,780
Printing	4	18	16	0	818	3,275	1,987	7,950
Tannery	3	48	49	107,500	29,066	87,200	32,050	96,150
Textiles	3	50	22	91,440	1,187	3,563	7,044	21,132
Total	26			1,419,555		1,378,273		1,879,108
Average		40	32		53,010		72,273	

the quality of leather, allowing a higher grading that commands an 8 percent higher price.

Given the small number of companies participating in the project, and limited replication, one cannot generalize from these data to assess the financial impact of EP3 on Chile as a whole. Moreover, economic events (a major recession, changes in market demand, etc.) appear to have had even greater effects on profitability than pollution prevention measures.

Environmental and Health Effects

EP3 managers estimated that their recommendations would reduce pollution on average by 32 percent at the 26 factories. The problem is a lack of before-and-after measurements. There were no baseline or postproject measurements of air and water pollution emissions. Although actual net air and water quality improvements attributable to EP3 measures are not known, the 32 percent estimate at these companies seems reasonable—a conclusion based on the sample survey conducted for this assessment.

Air pollutants were not a significant factor in most factories participating in EP3. Volatile organic compounds were emitted by some. A more important pollution source was the fuel used in the production process—wood, coal, or oil. A number of companies have switched to natural gas (which is much cleaner) and are also burning volatile organic compounds in the exhaust stack. The switch was driven mainly by the lower price of gas and (to a much lesser extent) to regulatory pressure. It has resulted in lower amounts of particulate matter and of sulfur dioxide emissions.

Going by 1998 data, the most notable improvement has been the reduction of ambient sulfur dioxide. During 1998, emissions met all Chilean federal standards, which are comparable to U.S. Environmental Protection Agency (EPA) standards and the more stringent California state standards. This is due almost solely to industrial conversion to natural gas and the use of natural gas for local power generation.

Particulate matter in the air comes from the fine dust of partially burned fuel and chemicals in exhaust smoke and from industrial metal grinding. When a person breathes these particles, they are trapped in the nose, throat, and upper respiratory tract. Small particles are the most dangerous, since they can be trapped deep in the lungs, causing long-term health problems.

Heavy air pollution harms human health, especially in the young and old and those with respiratory or cardiovascular problems. In particular, young children in Santiago have a much higher rate of acute respiratory illness than those outside the metro area.

No baseline effluent or water-quality data were available for this study; such data probably do not exist. It is estimated that 95 percent of all drinking water in the metropolitan area is treated. The real problem is sewage. There is little treatment of municipal effluent (stated to be 5 to 15 percent nationwide), as is evidenced by the open drainage canals running through Santiago. As a result, coliform levels downstream of discharge points are high. That is serious, as coliform is a major cause of diarrheal disease (particularly dangerous to children).

A second problem is industrial wastewater, which is typically mixed and discharged along with municipal wastewater. Industrial wastewater contains a wide range of pollutants, including organics and heavy metals such as cadmium, chrome, lead, mercury. This is an important factor in higher morbidity and mortality rates, as heavy metals are known to cause a wide range of cancers and neurological disorders.

Air and water quality standards are set primarily to protect human health. EP3 helped firms reduce their pollution discharges, meet discharge standards, and thereby improve human health. Proper disposal of industrial waste, including hazardous and toxic compounds, has reduced people's exposure to air pollution and runoff to surface waters, groundwater, and aquifers. Worker health and safety has also improved.

Examples of pollutants resulting from industrial operations audited by EP3, known health effects, and measures taken to reduce emissions and exposures are shown in table 2.

From the assessment team's onsite visits, it is clear that most firms are reducing air and water pollution emissions. Unfortunately, baseline and post-EP3 air and water quality data (and baseline emissions and effluent data) necessary to estimate or quantify impacts are not available. It is therefore not possible to quantify specific benefits for those factories or to estimate the overall health impact of pollution prevention measures.

PROGRAM PERFORMANCE

To be judged effective, a program and its pollution prevention concepts should gain sustained support from government and industrial groups. Benefits should be sustained and replicated after USAID funding ends. Finally, effective use of USAID assistance should generate a measurable impact on environmental quality.

Effectiveness

Effectiveness assesses how appropriate the intervention was in meeting program objectives. Was the program directed to the right group? Were the tools adopted relevant to the context in which they were implemented? Was implementation consistent in its approach, and was the approach the best way to use USAID resources to get the job done?

The institution first chosen to implement EP3 was the American–Chilean Chamber of Commerce (AmCham). As often is the case, the choice of AmCham was based on individuals at the chamber who were interested in pollution prevention. When they left, the program suffered. Those who took over lacked the same enthusiasm, and the project stalled.

In the second year, implementation was shifted from AmCham to a local environmental consulting firm, Qualitek, associated with Environmental Resource Management, a U.S.–based firm.

Both implementing institutions—AmCham and Qualitek—were careful to dissociate their technical pollution prevention activities from debates under way about how to establish and organize governmental institutions to develop and enforce environmental standards and regulations. The failure to engage Chilean authorities in a policy dialog during EP3's early years is noted by some people as one of its most significant weaknesses.

The quality of technical assistance was generally highly regarded. In addition, the technical approach of having one or two international experts working closely with Chilean environmental engineers on pollution audit teams was effective in identifying appropriate solutions for factories and providing a transfer of technology to local environmental firms. The weakness in the approach was that only a relatively small number of industrial companies were reached. Of 17,000 small and medium-size enterprises in the Santiago area, just 26 were chosen for environmental audits.

The difficulty in measuring program effectiveness lies in linking the economic gains to the EP3 approach. Enterprises that appear to have benefited most, such as the mining companies, the tannery, the dairy, and a textile factory, are

Table 2. Air and Water Pollutant Effects and Measures Taken Under EP3

Industry	Pollutants	Health Effects	Measures
Tannery	• PM • VOCs • Chromium	• Respiratory • Respiratory cancers • Cancers	• Baghouses • Evaporation barriers, water-based dispersants • Metal recovery
Printing press	• PM • VOCs	• Respiratory • Respiratory cancers	• Change to natural gas firing • Reduced use of oil-based inks
Hospital	• Pathogenic particles from incomplete waste incineration	• Spread of disease	• Offsite incineration and disposal
Electroplating	• PM from grinding • VOCs • Chromium, nickel and zinc	• Respiratory • Respiratory cancers • Cancers	• Cyclones and baghouses • Evaporation barriers, water-based dispersants, recovery • Metal recovery
Fish products	• PM, ammonia, odors • Organic matter • Ammonia	• Respiratory • Increased BOD	• Venturi scrubbers and cyclones • Recovery of solids
Dairy and cheese	• Organic matter	• Increased BOD	• Reduced water use, sale of whey
Slaughterhouse	• Organic matter	• Increased BOD, odors	• Wet scrubbers, use of landfill • Reduced water use
Textiles	• PM, organic fibers • Dyes	• Respiratory • Cancers	• Baghouses and change to natural gas for boilers • Nontoxic dyes, reduced use

PM=particulate matter VOC=volatile organic compounds
BOD=biological oxygen demand (in wastewater)

those that were dynamic and capable of modifying their industrial processes to take advantage of changing local and global markets. It can be argued that those firms would have adopted (possibly several years later) many of the pollution prevention processes. In fact, most introduced new technologies and clean production practices beyond those recommended by EP3.

Other small, less dynamic firms did not fare as well. Owing to a downturn in the local economy during 1998–99, many held back on carrying out clean production recommendations. This finding flies in the face of the potential financial returns. It is possible that smaller firms have different priorities and less capital and are unsure of the financial merits of pollution prevention, or that technologies may not have generated as large savings as expected by EP3.

In general, successful pollution prevention was associated with good plant management. Good managers are those who understand costs, product development, and marketing. They did well with pollution prevention. By contrast, industries and firms with severe pollution problems often had financial problems because of weak management. They were producing the wrong product mix with inefficient machinery.

Good managers saw pollution prevention as an integral part of efficient production. They adopted pollution reduction and waste minimization as a way to save money and improve product quality. There is a tendency for pollution prevention programs to zero in on companies with the worst pollution. That may be the way to clean up the greatest amount of pollution, but it is probably not the best approach if the goal is to achieve a broader impact. Pollution prevention efforts stand a better chance of success if they identify and work with the more progressive and better managed firms.

In sum, EP3's approach was technically sound but weak in both the scope of coverage and its follow-up. Technology transfer might have been improved by a more thorough investigation of the industries before initiation of technical audits. That would have enabled establishment of an industrial baseline so that improvements, both environmental and financial, could be quantified and valued.

It might, moreover, have been useful to target a group of companies in a single industrial sector, such as food processing or metal finishing. That would allow the project to demonstrate the merits of clean production and make sure it was adopted by a large number of companies producing similar products in one industry. The wholesale rather than retail approach would have enhanced replication. It might also have been more effective to start with companies that had greater potential for success or with owners who were more influential within their trade associations.

There were, to be sure, external factors that limited effectiveness. Terminating USAID's presence in Chile at the same time as the completion of EP3 meant there was little residual institutional support beyond the life of the project. By mid-1995, pollution prevention was picked up and given financial support by several international and bilateral donors—though most of the current representatives were unaware of EP3.

Sustainability

Sustainability of benefits is a key measure of success for a pilot project such as EP3. Sustainability can be assessed in part by whether people can recall after several years the program and its objectives. The evaluation team was often surprised at how few environmental professionals, other than those directly involved in the project, knew about EP3, its objectives, or its impact. Lack of follow-up with industry, the absence of policy dialog or establishment of strong relationships with government agencies, and failure to link lessons learned to dissemination and training efforts means that the program had little long-term effect.

EP3 had an important role in helping establish a viable local consulting services industry. The typical EP3 pollution prevention audit consisted of an American industry expert, a Chilean pollution prevention expert, and two or three Chilean consultants who received on-the-job training in the assessment process. Local consultants were given additional training at the Environmental Research and Training Center (Cipma). Complementing this was a training-the-trainers approach. It included short-term U.S.–based training for three persons and industrial engineering expertise from EPA experts brought to Chile for training sessions.

In part through EP3's training efforts, Chile now has a cadre of trained industrial environmental engineers working principally in the private sector and in universities. Many have progressed professionally to become managers and heads of environmental agencies that have important roles in pollution prevention. Several have established their own environmental consulting firms. The environmental services business started off with a burst in the mid-1990s but has slowed during the past few years owing to the downturn in the economy.

Early in the program, Cipma's training functions proved successful and useful. As a result, Cipma was selected by EP3 to serve as a clearinghouse for technical information. It was also to serve as a vehicle for postproject training and dissemination of information intended to sustain the project's work following termination. But the effort to institutionalize EP3 activities through Cipma failed. The reasons are many, but they centered on Cipma's status as a mere think tank, giving the group little credibility with government or industry.

The philosophy of pollution prevention has been incorporated within the regulatory framework and environmental standards adopted by Conama, Chile's EPA. The future of pollution prevention and clean production looks bright. Chile's Ministry of Economy has adopted a wide-ranging pollution prevention program with an initiative called the Public–Private Partnership for Clean Production. The aims of EP3 have been institutionalized, and commitments have been made to ensure that pollution-prevention concepts are sustained.

Can these positive results be attributed to EP3? Again, the importance of people who participated in the project was cited as being influential in persuading the Ministry of Economy to adopt its clean-production program. Chilean environmental engineers who took part in EP3 were also influential in promoting the expansion of a government-initiated clean-production program. But pollution prevention is a universal concept. It can hardly be said to be "owned" by a project or program. Many other international and bilateral donors provided pollution prevention services to Chile in the interim. They would also surely claim credit for sustaining a program of clean production.

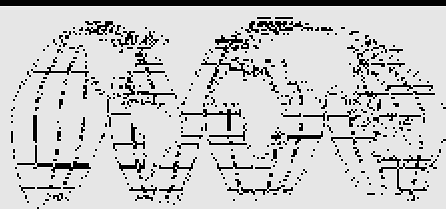
Project planners and USAID can be given much credit for recognizing an important developmental need in Chile and responding early in an effective way. More attention to follow-up and to formulation of a plan for sustaining the project after its termination might have resulted in greater sustainability of EP3 benefits. EP3 planted the seed for pollution prevention programs but was not around to see the accomplishments wrought by its efforts.

Replication

Replicability refers to the difficult process of extending project benefits beyond the original participating companies to other companies.

EP3's program management recognized that to be effective, industrial audits had to be customized to the needs of participating firms. To overcome the reluctance of firms to divulge industrial secrets, agreements were made with each participating firm to protect proprietary information about that firm's industrial process. Information and outreach about the pollution prevention processes adopted by firms faced two barriers: 1) the audits themselves were considered proprietary information and could not be shared, and 2) owners and plant managers were reluctant to share information about operational changes that resulted in cost savings. They wanted to protect their competitive positions.

The evaluation team found, however, that the more influential the person involved in the Pollution Prevention Diagnostic Assessment, and also to some extent the more prosperous and established the company, the more likely the broad, nonspecific benefits were disseminated to others in the industry. For example, the president of the Chilean Tanneries Association took part in an EP3 audit. He continued to praise the results of EP3's technical assistance to other members of the association and pushed the lessons learned at industry meetings. Similarly, a prosperous and well-established textile manufacturer who participated in an EP3 audit became a strong advocate of pollution prevention audits within his industry. He did so without divulging specific competitive benefits his company received. In these instances the reputation of participants enhanced replication of the project's benefits.



"The more influential the person involved in the Pollution Prevention Diagnostic Assessments, the more likely that benefits were disseminated to others in the industry."

An example of significant replication was the Valparaíso Hospital. As a public hospital, medical staff had little concern about the profitability of pollution prevention measures. They were concerned, though, about the effect of such measures on the health of patients and staff, and the maintenance of environmental health and safety in the workplace. The audit led to greater management coordination of medical services in general. As a result, medical staff used EP3's audit procedures to develop a training and outreach program for other medical services at the hospital and for workshops in university settings. The outreach had two purposes: first, to highlight improved measures to handle medical and toxic wastes, and second, to share systematic measures to assess and improve hospital administrative procedures for greater coordination of services among medical staff.

The reasons are many why replication and outreach were limited. Addressing specific problems of individual companies meant that an environmental audit of one firm was not easily transferred to others. Many recommendations were generic. Except in the case of no-cost or low-cost in-house process improvements, the recommendations lacked specifics of how, where, and when to acquire the recommended technologies. Replication could have been enhanced if companies knew not only what technologies to use but also how and where to install them, where to buy the equipment, and possible sources of financing. Promoting American goods and services was an explicit objective of EP3, but few sales were generated.

A more integrated approach would have examined the total waste stream, from before the time it reaches the plant through the production process to end-of-pipe waste-treatment alternatives. This approach might have targeted firms within an industrial sector or within a geographic area. Such an approach might have led to greater outreach and more expansive coverage for industrial sectors and integrated solutions to waste management.

LESSONS LEARNED

The Chile Environmental Pollution Prevention Project successfully introduced the concepts of pollution prevention and clean production to Chile's industrial sector. Compared with end-of-pipe pollution treatment, companies found that with EP3 pollution prevention they could save money while also reducing environmental pollution. Pollution prevention is now fully accepted throughout Chile's industrial sector. While EP3 was successful at selling the pollution prevention message and having 26 factory demonstration efforts, there were some missed opportunities. The lessons that emerge from this assessment are summarized below.

1. Institutionalization. *A pilot effort is an excellent way to experiment and test ideas and methods, but it should include a plan to scale up, disseminate, and sustain successful approaches.*

EP3 assumed that pollution prevention techniques, once adopted, would generate substantial benefits and that companies would recognize the value of the EP3 approach. It would then be adopted throughout the economy. EP3 succeeded in creating a cadre of pollution engineers and working with the private sector. But it did not extend its message throughout the industrial sector and failed to develop close ties with the government or NGOs. There was no effective institutional arrangement to carry on the effort after USAID assistance ended. **Designers and implementers of pilot programs need to develop a sustainability plan to ensure that benefits continue once the program ends. That usually requires an institutional structure with adequate funding and skills to maintain program benefits.**

2. Replication. *EP3 helped companies reduce pollution, increase profits, and improve their competitive position. But participating firms were reluctant to share the newly learned techniques with competitors.*

EP3 recognized that Pollution Prevention Diagnostic Assessments had to be customized to the unique production process of participating companies. But each company closely guards its production techniques, not wanting to help competitors. Agreements were made to protect this proprietary information. As a result, there was only limited dissemination to other firms in the same industry. Exceptions took place when the audit was done at a plant where the owner was an influential leader in the industry trade association. **Replication will not take place if it reveals trade secrets. A program needs to develop ways to replicate generic pollution prevention approaches.**

3. Targeting. *Good factory managers are those who understand costs, product development, and marketing. They also do well with pollution prevention.*

In Chile, firms with severe pollution problems often had financial problems, owing to weak management. They were producing the wrong product mix with inefficient machinery. They were the "losers." In contrast, good managers saw pollution prevention as an integral part of efficient production. They adopted pollution reduction and waste minimization as a way to save money and improve product quality. There is a tendency for pollution prevention programs to concentrate on firms with the worst pollution problems. That may not be the best approach to achieve sustained impact. **Pollution prevention efforts stand a better chance of success if they identify and work with the more progressive and better managed firms.**

4. Timing. *It is important to be ahead of the wave, but if a pollution prevention program is too far ahead of a country's environmental consciousness, benefits will be limited.*

When EP3 was launched, environmental awareness and interest by the government and industry had just begun to grow. Chile had almost no environmental regulations in place. The law requiring environmental impact assessments, the start of enforcement of pollution regulations, and establishment of the government environmental agency (Conama) all took place as the project was coming to an end. Without regulations, or enforcement, EP3 set about selling pollution prevention directly to industry as a cost-saving measure. That proved to be a difficult task. **If pollution laws are not in place, a pollution prevention program may need to work with a country to develop its environmental policies and regulations before it undertakes to persuade industry to adopt pollution prevention measures.**

5. Regulation. *Cost savings alone may be insufficient to induce companies to adopt waste minimization and pollution prevention programs.*

Until the early 1990s, pollution laws were few and enforcement was rare. Moreover, Chile had a history of a strong central government with the military in control until 1990. Business leaders and the government still had an ingrained command-and-control mentality. With an absence of regulations and little concern about pollution, EP3 had difficulty persuading a large number of firms to adopt clean production measures. Many companies viewed pollution prevention as a cost that might not generate any return on investment. Several years later, firms became interested in clean production and pollution prevention when they faced the threat of fines, government sanctions, and penalties charged by the wastewater authority. **While both the carrot and stick (cost savings and regulations, respectively) are important in motivating companies to take action, regulations and fines clearly command the attention of factory managers and create demand for pollution prevention measures.**

6. Wholesale versus retail. *A program cannot hope to reach all firms directly but needs an intermediary to spread the message.*

There are 17,000 small and medium-size industrial firms in the Santiago metro area. EP3 tried to work with industry groups and trade associations, but the efforts had only limited success. Instead, EP3 used a retail approach, providing general public training sessions and working with one factory at a time. It did not succeed in reaching many firms. **A demonstration project cannot hope to succeed with a retail approach of dealing with one firm at a time. Impact will be greatest when an institutional structure (such as an industrial trade association or a clean-production center) exists to disseminate pollution prevention findings throughout an industry.**

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