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PAUL F-BRANDWEIN LECTURE

Watershed Education for Sustainable Development[1]

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Global Rivers Environmental Education Network (GREEN) is an international network that seeks to bring students, teachers, and communities in the world closer together through the bond of studying and improving our river systems. The network is an expanding global communication system that invites participants to analyze watershed usage, monitor the quality and quantity of river water, reflect on ways that land and water usage and cultural perceptions influence river systems, and present their findings and recommendations to appropriate governmental and nongovernmental organizations. The pedagogical model that GREEN has been working under is ''Action Research and Community Problem Solving (ARCPS).'' It is a process that enables students and teachers to participate more fully in the planning, implementation, and evaluation of educational activities aimed at resolving an issue that the learners have identified. Some of the cornerstones of the instructional approaches are watershed analysis, experiential learning, interdisciplinary orientation, integrated problem solving, action-taking, and the support of networks. GREEN encourages classrooms to consider a cross-cultural component to their watershed education program in an effort to further global citizenship by linking students, teachers, and community members from different regions of the world.

KEY WORDS: Education; watershed; monitoring; empowerment; action research; cross-cultural.

PAUL F-BRANDWEIN

Paul F-Brandwein taught at Forest Hills High School, New York University, Columbia University, and Harvard University. Many of his teaching experiences were translated directly into professional manuals, articles, and textbooks.

He served as Director of Research and Assistant to the President of Harcourt, Brace and World, Inc., and Director of the Pinchot Institute of Conservation Studies. He also served as Associate Director of the Joint Council on Economic Education, was a member of the steering committee for the Physical Sciences Study Curriculum, and the Biological Sciences Curriculum Study.

He conducted numerous seminars, conferences, and workshops for teachers in many school systems, including Los Angeles, Seattle, Houston, Baltimore, South Bend, Washington, D.C., and Chicago, to mention only a few, as well as Yale, Harvard, Columbia, and Colorado Universities.

Dr. Brandwein held degrees A.B., M.SC., and Ph.D. in Biology, the latter from New York University. He was elected to Phi Beta Kappa, Sigma Xi, and was a Fellow of the American Association for the Advancement of Sciences. He also held a D.Sc. degree (Honorary) from Colorado College, was a Ford Fellow, and a Burton Lecturer at Harvard University. (Brandwein, Paul F-, 1986)

I first met Paul 35 years ago when he served as Director of the Pinchot Institute for Conservation Studies in Milford, Pennsylvania. He convened a meeting of formal and nonformal educators to iden-

[1]This was the first lecture in the Paul F-Brandwein Lecture Series, The series, reflecting on the wisdom and vision of Paul F-Brandwein—scientist, author, artist, master teacher, and humanitarian—recognizes leaders in education who identify human intedependence with nature and human responsibility for maintaining a sanative environment. The lecture is presented annually at the National Science Teachers Association National Convention. The lecture is endowed through the Paul F-Brandwein Institute, Inc., Greenville, New York.

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tify ways to integrate conservation into the main stream of education in North America.

This contribution in many ways builds on the educational philosophy, cognitive framework, instructional techniques, and interdisciplinary curriculum strategies developed by Paul F-Brandwein. Brandwein (1973, 1981, 1986), following in the footsteps of John Dewey (1933, 1963), strongly felt that if students were to be contributors to society they needed to be

> Grounded in all areas of the curriculum;
>
> Linked to real life experiences;
>
> Provided school and community interaction;
>
> Experienced in individual and group investigations;
>
> Problem solvers, not problem doers;
>
> Persistent in seeking explanations;
>
> Allowed the time to think and seek solutions;
>
> Mentored to work toward responses; and
>
> Informed at the local and global level.

Brandwein was an advocate of models of instruction that view the teacher not just as a conveyor of knowledge, but as a facilitator of learning. This learning takes full advantage of community resources and the abilities of the students—''experience feeds knowledge, and knowledge feeds experience; the known feeds the unknown, and the unknown catalyzes knowing. The teacher is a guide, not the guardian of the archives. A child can and should learn in all ways—by voice, by book, by machine, by investigation, but above all, by example. A teacher can not be replaced; a lecturer can'' (Brandwein and Wilson, 1973).

The purpose of this article is to focus on the past, present and future of the Global Rivers Environmental Education Network (GREEN). GREEN is an innovative and action-oriented approach to education based on an original interdisciplinary watershed education model which reflects many of the ideas developed by Paul F-Brandwein. GREEN's mission is to improve education through a global network that supports local efforts in watershed education and sustainability. GREEN is a resource to schools, youth organizations, and communities that wish to study their watersheds and rivers, and work to improve the quality of life. GREEN is a non-profit organization linking teachers, students, administrators, and professionals in watershed education programs in all 50 states and in over 135 nations. This article provides information on the need for international watershed sustainability, the roots of GREEN, the pedagogical GREEN model, the development of GREEN internationally, and the future of GREEN.

THE EDUCATIONAL SETTING

''Globalization'' refers to our increasingly interdependent world, linked by an ever more interactive world economy. Our world is made more intertwined by massive environmental issues that transcend national and international boundaries—issues that can be addressed only through an unprecedented degree of global cooperation and action (Stapp *et al.*, 1996b).

One major challenge that will increasingly confront environmental educators is to develop curricula and instructional strategies that emphasize the global component of local environmental issues, but do not overwhelm students or cause them to lose hope. How can we educate and empower students to take action on local issues while simultaneously developing within them an international cross-cultural perspective? How can we best encourage this first generation of truly planetary citizens to assume responsibility for their shared home? (Stapp *et al.*, 1996b).

Rivers were selected as the central focus of this global, experiential, interdisciplinary, action-taking approach because rivers are a reliable and informative index of environmental quality of our land. Rivers also form a natural link for relating chemistry to biology, and the physical sciences to the social sciences, and humanities. Rivers bind together the natural and human environment from the mountains to the sea, and from farmland to the inner city. Rivers were the sites of early civilization because they provided fresh water for drinking, as well as fish and other food. Floodplains along our rivers provided rich areas to grow crops, and the rivers themselves are used for transportation. Rivers also contain a historical perspective of cultural diversity and can be a vehicle for cross-cultural dialogue. For these reasons, the study of rivers forms a coherent curricular framework for study of a wide range of environmental studies and issues (Stapp and Mitchell, 1996).

Environmental educators have long recognized the educational potential of water resources. Many activities, lessons, and fieldwork in environmental education revolve around water quality monitoring and protection.

Many of these programs have an education component that seeks to involve schools and their surrounding communities in addressing water resource

management issues and to explain the significance of these issues for maintaining a high quality of life for human and non-human species. Some programs focus primarily on a local watershed, wetland, lake, or coastal area, whereas others also explore the global dimension of local issues by linking communities elsewhere in the world. Many groups tie into GREEN, which for more than 10 years has actively promoted interactive community-based water quality monitoring.

Today, a worldwide network of people interested in water quality monitoring and water resource management issues are in contact with each other and with the staff of GREEN. As a result, we are now able to tap into a rich pool of water quality monitoring initiatives. With so many active programs, we see the important opportunity to learn and to benefit from each other and with the staff of GREEN.

Judging from GREEN's rapid expansion, the numerous daily requests for information it receives from around the world, and the recognition the network has received, GREEN appears to offer a desirable educational approach. However, when considering GREEN's higher learning goals, such as the acquisition of integrated knowledge and the building of problem-solving skills, its success is not as widespread as needed in the world today (Stapp *et al.*, 1996b).

INTRODUCTION TO RIVERS

Water sometimes seems to be an unlimited resource. However, the use and abuse of water resources by an increasing human population and an ever-expanding industrialized society have begun to seriously affect the very nature of water and the water cycle itself. Increasing global urbanization is placing new demands on both surface and underground water resources. Throughout history, joint use of river basins has always depended on cooperation among riparian states. Failure to reconcile the competing interests of upstream and downstream users has generated considerable political conflict in the world today.

For example, in the states on the Arabian Peninsula south of the borders of Iraq and Jordan, including the Kingdom of Saudi Arabia, Kuwait, the United Arab Emirates, Bahrain, Qatar, Oman, and Yemen, there is not a single stream that flows the year around. The 23.3 million people living in this area are completely dependent on underground aquifers. These aquifers do not exist in isolation from the hydrologic cycle. They must be recharged by precipitation elsewhere in the watershed area. If water is managed irresponsibly in the upper reaches of the watershed, the lives of millions of people in the down river watershed will be affected negatively. The citizens of the Arabian Peninsula must practice effective water management themselves and they must work in cooperation with nations in the headwater regions, such as Turkey and Syria, in order to guarantee their future survival (Stapp and Mitchell, 1996).

Dr. Mostafa Tolba, former Executive Director of the United Nations Environment Program (UNEP) and current President of the Center for Environment and Development, recently stated that international competition for water and land could endanger political ties. If present consumption patterns of water continues, it will lead to the loss of food resources and more competition and conflict. Tolba stated that ''food security'' depends on how well the country manages their land. Dr. Tolba connects ecological stability with political stability.

Degraded water quality in the developing world is a severe problem that will need to be tackled before sustainable development can be accomplished. In the third world, over 5 million children under the age of 5 die each year from the water they drink. Eighty percent of all sicknesses are due to unsafe water resulting from land drainage and poor sanitation. One of four hospital beds is occupied by people with waterborne diseases (The World Conservation Union, 1991).

Most citizens in industrialized countries have access to safe drinking water, but this does not mean they no longer have to worry about monitoring for water quality. Point source pollution has been decreasing in many countries, but nonpoint sources continue to cause many problems, especially with groundwater supplies. The water that flows over land and into rivers also percolates through the soil to recharge deep groundwater aquifers. Land use practices that are polluting streams and rivers have the potential to pollute these groundwater sources as well. The industrialized countries of Europe and North America face increasing contamination of groundwater reserves. In the United States, up to 2% of our deep aquifers may be unsafe for drinking water. Pollution from nonpoint sources such as fertilizers and pesticide residues in farm runoff, de-icing salts in runoff from city streets and highways, leaking underground sewer lines, surface and deep mines, and inadequate disposal of chemical and other haz-

ardous wastes are mostly to blame. In addition, many arid regions are mining their deep aquifers. Because aquifers are generally recharged at a very slow rate, continuous groundwater mining can lead to immense water shortage for future generations (Stapp and Mitchell, 1996).

Many international watersheds are threatened by activities, like agricultural chemicals being washed into surface waters causing cultural eutrophication and lower species diversity; industrial waste released by food factories and chemical plants increasing biochemical oxygen demand; accumulation of toxic substances, like heavy metals and phenols in the sediments near industrial outfalls, poisoning benthic organisms, and shell fish; drainage of thousands of small settlements established on the shores of river systems that frequently lack waste water treatment facilities, and contribute to hepatitis outbreaks and other human diseases; and poorly designed irrigation schemes creating condition leading to oxygen loss, water logging, salination, destruction of soil fertility, and loss of food production.

Examination of recent Environmental Protection Agency data reports on thousands of United States rivers from 1984 to 1999 find that the percentage of rivers designated as ''impaired'' has grown from 26% in 1986 to 36% in the most recent reports (rivers are classified as ''impaired'' when they cannot support aquatic life or are unsafe for fishing or swimming). Pesticides and bacteria are a growing concern in Mississippi, metals and salt in Arizona, trash and fertilizers in Georgia, and nutrients and siltation in California. Water in one-fourth of the wells in many agriculture areas has become unsafe to drink owing to high levels of bacteria and nitrates. Public water systems that serve several hundred towns and cities in the midwest are contaminated by herbicides (Loeb, 1998).

The portions of all ''impaired'' rivers in the United States affected by different sources of pollution are: agriculture, 70%; silt, 51%; nutrients, 40%; construction, 37%; bacteria, 32%; pesticides, 21%; city sewage systems, 14%; urban and suburban runoff, 13%; mining, 13%; and industry, 9%. These totals do not equal 100% because more than one pollutant may impair a river (Loeb, 1998).

It is clear that there is a need for a national and international framework for integrating development and conservation. All nations need a foundation of knowledge and information exchange, a framework of law and institutions, and consistent economic and social policies if they are to advance in a rational way. National and international programs for achieving sustainability must be adaptive and continually redirected in response to new experiences and to new needs.

THE ROOTS OF GREEN

The roots of GREEN started in 1984 when a biology class at Huron High School in Ann Arbor, Michigan, became concerned about the water quality of the river that flowed by their school. The students knew that the Ann Arbor Parks and Recreation Department leased a windsurfing concession at a city park bordering their school. Several students in the class, as well as local residents who used the river for windsurfing, had contracted hepatitis A. The class realized that water quality formed a potential health threat and their concerns fueled a 3-week investigation of the Huron River. With the cooperation of university resource people, the biology class tested the water for the nine parameters designated by the National Sanitation Foundation as critical indicators of water quality.

The investigations revealed that after heavy rains, the fecal coliform count reached levels high enough to categorize the river water unsafe for body contact. The question quickly became, ''Is windsurfing a body contact sport?'' Their findings and opinions were sent to the County Health Department, the City Parks and Recreation Department, City Council members, published in the school newspaper, and appeared in the *Letters to the Editor* section of the local newspaper. As a result, the concerned City Council funded the University of Michigan's School of Public Health to test the water quality of the Huron River at regular intervals. It was soon learned that approximately 70 businesses and homes in the city had sanitary waste lines illegally connected to storm water lines that drained directly into the Huron River. Raw sewage would accumulate in these lines and flush into the river after a rainfall, posing a health hazard to people using the river for recreation. These findings triggered the development of a formula that could help predict when the river should not be used for windsurfing.

The high school students then collaborated with the city on the design of a sign posted on the river bank to warn windsurfers. The sign stated

> DUE TO STORM RUN-OFF FROM RECENT RAINS, BACTERIA LEVELS

IN THE RIVER EXCEED STATE WATER QUALITY STANDARDS.

FULL BODY CONTACT IS NOT RECOMMENDED.

Later, the city decided not to renew the lease of the windsurfing concession.

The interest in this high school water quality monitoring project on the part of the teacher, the students, and the collaboration from the University of Michigan, led to the involvement of other high school classes in different communities along the Huron River. These multiple high schools on the Huron River started to come together to share their data collected from different points on the Huron River, and to form a collective picture of the water quality and potential actions to be taken in rural and urban stretches along the river.

In 1987, the Huron River project caught the attention of ''Friends of the Rouge,'' a non-profit community organization in the Detroit metropolitan area that arose out of the realization that the Rouge River in Southeastern Michigan had been abused and neglected for too long. This group recognized that a water quality monitoring project for high school students would be an effective way to raise youths' awareness and concern towards the river, and to draw media attention to the Rouge and its problems.

The Friends of the Rouge funded students and educators from the University of Michigan's School of Natural Resources and Environment to establish a pilot project involving sixteen schools distributed throughout the Rouge River Watershed. With the assistance of teachers from the pilot schools and Friends of the Rouge, the university team developed an interactive water monitoring program for schools that is now widely known in environmental education circles as the ''Rouge River Model.'' Today, there are over 100 elementary, middle, and high schools in the Rouge River Watershed program (Wals *et al.*, 1990b).

In 1989, the Saginaw Public Schools with support of the General Motors Corporation developed a community-wide, interdisciplinary, action-taking program on the Saginaw River. This program was later expanded to over 200 schools in 12 midwestern watersheds and 2 Canadian watersheds that drain into Lake Erie. A key element in these programs was the ability to share ideas and questions between students, teachers, community groups, and agencies throughout the watershed via a computer conference. School computers were linked through a telecommunication network to one central ''host'' that acted as a clearing house for storing and forwarding of communication and results.

EDUCATIONAL COMPONENTS OF INSTRUCTIONAL PROGRAM

Watersheds form the central focus of investigation in GREEN-type programs. It is the organizing unit that transcends physical, political, and social boundaries. Most rivers originate in rural areas and flow through suburban and urban areas as the river collects water and drains toward larger watersheds and/or the ocean. Such linkages provide the opportunity to bring diverse socioeconomic and racial populations together to learn more about each other and work jointly to help resolve issues that affect us all (Wals *et al.*, 1993). The initial 6 years of program development led to the following ''Watershed Educational Model'' used in most GREEN programs (Mitchell and Stapp, 1998).

GREEN's Watershed Educational Model

History and Culture

Knowledge of indigenous settlements and cultural and environmental relationships within the watershed; early immigration patterns; the process of urbanization; and municipal sanitation concerns and efforts are studied.

Land-Use Practices

Provision for field studies and excursions; use of maps and aerial images to note changing land-use practices and their impact on water quality; and identification and recognition of the value of wetland areas are provided.

Use of Senses

Collect river information using one's natural senses: sight, smell, hearing.

Benthic Organism Studies

This includes noting the value of biological monitoring; identifying the diversity of aquatic life in the

river; and studying what organisms are present or lacking. Organisms are identified by using a key, and classified into four groups based on their pollution tolerance. The pollution tolerance index is determined by multiplying the number of kinds of organisms in each group by its index value. These numbers are then added together to form the Index.

Nine Water Quality Tests

Water is tested for critical physical and chemical parameters using low-cost monitoring equipment. The nine parameters used in most GREEN programs are dissolved oxygen (% saturation), fecal coliform (colonies/100 mL), pH (units), BOD (mg/L), temperature (change between 1 km upstream and the sampling site), total phosphate (mg/L), nitrates (mg/L), turbidity (NTU), and total solids (mg/L). After the nine water quality tests are completed and the results of each test are recorded, an overall Water Quality Index for the section or sections of the river monitored can be computed and compared with other river sections.

Computers and Networking

Graphing paper or computers are used to record and analyze river data; communication within or between watersheds in reference to the data collected; and responding to questions.

Laws and Regulations

Laws and regulations are identified that govern water quality in the region, and familiarity with regulatory agencies in the watershed or region and their responsibilities is gained.

Cross-Cultural Exchange

A cross-cultural partner within one's watershed or in another region or nation is developed to share information and respond to questions. In a world where environmental problems no longer conform to political boundaries, cross-cultural communication forms the basis for better international understanding, cooperation and action.

Student Congress

Discussion of water quality data and the sharing of concerns take place with others in the watershed. Water quality data and concerns to the regulatory agencies in one's region are presented, and responsible action steps are developed. To improve water quality in the watershed.

Futurism

The consequences of environmental trends that are shaping our future (forest loss, soil erosion, water scarcity, coral reef destruction, etc.) are considered. There is a focus on environmental sustainability concepts.

Action Taking

Action competence and empowerment are developed by taking learner-initiated appropriate action on the environmental information collected and discussed. Examples of successful student action are identified.

Evaluation

An on-going evaluation procedure is developed to determine what changes are occurring at the student, teacher, institution, and/or community level.

In carrying out the above "*watershed educational model*," the core educational approaches that have interested students, teachers, schools, and communities in GREEN-type programs, are as follows.

Watershed Analysis. A watershed—the drainage area of an entire river system—is an excellent medium for teaching students the systematic analysis and integration of information and knowledge. Our land use practices have a strong influence on the quality and quantity of water throughout the watershed in which we live. Whether we remove vegetation along the banks of a stream or leak toxic chemicals into a river from a factory, our actions have an effect on the river system. The study of a local watershed forms the central subject of investigations in water quality monitoring educational programs. Aerial images, maps, excursions, interviews, field studies are used to note changes in land use practices and the

impact of these changes on river water quality. (Stapp *et al.*, 1996a).

Experiential Learning. The experiential approach toward education brings students out of the classroom and provides opportunities for them to study and help resolve real world issues. Experience and research have shown that people are characteristically more interested in what affects them directly. Captured on a personal level, this interest inspires genuine learning and action that can motivate change both on the individual and the community level. Developing a deeper understanding of local issues and learning about the actions of other students can empower participants to make a difference in the world. At the same time students come to experience the value of science, mathematics, and technological knowledge as they engage in their practical application when monitoring and analyzing the watershed. It is through direct learning experiences that students are more likely to recognize the relevance of science for improving their own lives, be able to adapt better to an increasingly technological world, and contribute to resolving science-technology-society issues responsibly. It is critical to youth education that the ''student'' be involved in the planning, collection, analysis, and taking responsible action—not just the teacher (Wals *et al.*, 1993a).

Interdisciplinary Approach. Becoming a student of the world's rivers requires going beyond any one way of thinking. A river study should be an interdisciplinary investigation. The studying of local water systems can link science, humanities, social studies, and geography classes, and enhance the development of more scientifically and environmentally literate students who are capable of understanding and addressing specific issues that are of concern. Undertaking a watershed study ideally becomes a series of interdisciplinary exercises melding water ecology field studies with historical and sociological investigations of the local water and land use systems. With this approach, students build understanding of the complex cause-effect links that have created local problems, and realize that these problems are often local manifestations of global issues. By addressing water quality issues, students enter the cross-section of three important domains of contemporary education: science, technology, and society. Resolving these issues requires knowledge of all three domains and an ability to integrate this knowledge into one's own decision-making process (Bybee, 1987; Yager and Penick, 1986).

Integrated Problem Solving. Problem solving is a process that enables students and teachers to participate more fully to resolve an issue that learners have identified. This differs from more traditional studies, which more narrowly focus on goals and objectives that have been presented by outside experts. This rich immersion into the local environment provides students with a level of feeling and knowledge that can empower them to become effective problem solvers. They learn to recognize problems in their objectives; collect, organize, and analyze information; define the problem from a variety of perspectives; identify, study, and select actions that may lead to improvement of the problem; and develop and carry out a specific plan of action; and evaluate the outcome and the entire process (Brody, 1982; Wals *et al.*, 1990a). During the problem-solving process, students become engaged in group work, joint decision making and other skills needed to function in a democratic society (Wals *et al.*, 1993b).

Action-taking Strategies. It is important to both test the rivers to determine the river's health, but also prescribe ''treatment'' or course of action. GREEN encourages participants to go beyond the discussion of solutions by developing action-taking strategies. The network (computer network, newsletter, cross-cultural partners exchange, and a range of workshops) facilitates the exchange of different methods of problem solving and action taking. Students can share experiences that were successful and not so successful as they develop strategies on what to do in their own community. A focus on water quality studies and watershed land-uses encourages students to look beyond their books for education and try to improve their local environment. Students find very creative ways to educate their communities about water quality. Some culminating action-taking steps by students involved in a GREEN water quality monitoring program include the following.

- Established a community-wide ''hazardous waste collection and disposal day''
- Promoted laws and posted areas to prohibit power boats or reduced their speed limits in an effort to save the endangered manatee
- Stenciled messages on street curbs to alert people to avoid dumping wastes into storm drains directed to the river
- Prepared and delivered weekly radio announcements on local river history, river monitoring results, and student water quality concerns
- Developed a school policy concerning use of lawn chemicals on school property

- Worked with city council to post the river against water-based activities until water quality could be improved
- Participated on national television calling attention to untreated sewage effluent being discharged into an ocean-based recreational area
- Performed environmental audits for local businesses and provided advice on soil runoff and erosion

If carefully guided and properly focused the problem-solving and action-taking components of the program, can be an empowering experience for both teachers and students (Wals *et al.*, 1993a; Mitchell and Stapp, 1998).

Support Networks. Through involvement in a river network, students can share information, technologies, and actions taken on local rivers. They also can learn that their investigations are valued by their peers. Acknowledging the challenges of interdisciplinary and experiential education, GREEN tries to facilitate the formation of collaborative support systems of the schools and the teachers involved in a watershed monitoring program. These systems consist of workshops, newsletters, computer telecommunication conferences, and multi-media forums to share expertise and to provide internal support. Within each program, GREEN encourages the formation of links between the school and the community and the creation of a community of learners (including parents and representatives from neighborhood groups, businesses, industry and government) willing and able to support each other in creating a stimulating environment in which students can explore their watershed. GREEN also encourages classrooms to consider a cross-cultural component to their watershed education program. Cross-cultural partners further the idea of global citizenship by linking students from different regions of the world. This allows participants to share technical, scientific, social, and cultural information on their respective river systems. A critical aspect for preparing for a cultural partner is deciding what type of information the group would like to exchange.

GREEN has developed an on-going ''partnership'' network for carrying out its educational, scientific and cultural mission. GREEN's partners include businesses, industries and corporations; local, state, and national governments; international organizations; foundations and consortiums; natural resource commissions; universities and colleges; international agencies and programs; and other partnerships. These partners have helped to conceive, develop, promote and finance GREEN's multiple goals and objectives. More specifically, these partners have helped GREEN to develop low-cost water quality monitoring kits, formulate cross-cultural partner programs, develop software and computer technology, access remote sensing maps, prepare instructional materials, establish global communication connections, sponsor specially designed workshops, and improve global networks to promote watershed sustainability. GREEN also uses the 50 or more country coordinators to identify and adapt programs for unique cultural settings. This partnership network has been essential in helping to both create and expand GREEN's effort in watershed education and sustainability (Stapp and Wals, 1994; Stapp *et al.*, 1996d; Wals *et al.*, 1993b).

INTERNATIONAL DEVELOPMENT OF GREEN

There are over 200 international river basins (shared by two or more nations) in the world, representing over 47% of the global land surface and 60% of the combined land area on the continents of Africa, Asia and South America (Frederick, 1996).

Our initial international watershed educational model was developed in the Great Lakes Region between Canada and the United States, and on the Rio Grande (Rio Bravo) bordering the United States and Mexico.

Between 1984 and 1989, the University of Michigan was contacted by various communities in different regions of the world wanting to share and obtain more information on watershed education. Based on an expanding international interest in watershed education, 26 university students and faculty with background in water quality and environmental education responded by organizing an advanced Environmental Education course in January of 1989. The students and faculty designed the original direction of GREEN as they laid the foundation for this international network. The class members then traveled to and helped organize 22 workshops in 18 countries located in Africa, Latin America, Europe, Middle East, Asia, and Oceania during the summer of 1989. Each country workshop brought together educators, administrators, citizens, resource specialists, students, and representatives from governmental and non-governmental organizations to exchange thoughts and ideas on watershed education. Some of

the aims of each workshop were to discuss approaches to experiential field trips, cross-discipline teaching, and to explore how watershed education programs might support the educational and instructional goals of the involved nation.

GREEN held its First International Congress in Sydney, Australia, in 1995. This Congress resulted in the formation of international regional teams of Country Coordinators in Africa, Middle East, Latin America, Asia, Europe, Australia, and Pacific Oceania. The conferees developed a full matrix of short- and long-term goals and activities. Their work built the foundation for the planning, operations and evaluation of GREEN's international network over the next 5 years, and provided a blueprint for GREEN's activities globally. The Congress participants also outlined criteria for selecting new Country Coordinators and defined their role, which was useful in expanding the network on all continents.

GREEN has kept a strong commitment to both national and international river basins since its founding. In 1996, *International Case Studies on Watershed* Education was prepared (Stapp *et al.*, 1996b). This publication highlighted GREEN activities, programs, and river data on many international rivers, such as

- *Europe*: Danube River, Maas River, Rinya Creek, Drava River, Elbe River, Rhine River, Volga River, and Mincio River
- *Asia*: Ganges River, Deg Nullah River, Tansui River, Brahmaputra River, Meghna River, and Han River
- *Latin America*: Rio Grande River, Orinoco River, Amazon River, Negro River, Parana, and Rio de la Plata River
- *Africa*: Nzoia River, Athi-Galena River, Mzima Springs, Nile River, Zaire River, Zambezi River, and Senegal River
- *Middle East*: Na'aman River, Euphrates River, Tigris River, Jordan River, and Orontes River
- *Australia*: Murray Darling River, Torrents River, Greendale Creek, Flinders River, and Maroochy River
- *North America*: Rouge River, Cuyahoga River, Budd/Deschutes River, Ionkwaniatarra River, Kawai Nui Marsh, and Fraser River

From these international studies we obtained environmental information, such as rivers varied in quality from very pristine to highly polluted. For instance, nitrogen levels in some Swedish estuaries has increased by 200% since the 1950s. In Japan, Minamata Bay has received 600 tons of inorganic mercury since 1953; the Tansui River in Taiwan contained at midday 0.0 mg/L of dissolved oxygen, 138 ppm biochemical oxygen demand (BOD 5-Day), and high concentrations of heavy metals and toxic organic compounds. It is also recognized, that 7.8 million Third World people die each year from the air they breathe and the water they drink. In many parts of the world, there are no pipes to distribute clean water to residents or waste water treatment facilities to reduce pathogens from entering waterways.

We also obtained useful educational information that allowed us to further adapt GREEN to local circumstances, such as Third World nations emphasizing low technology and needing to have access to low-cost water quality monitoring kits. Many geography teachers in Africa have been trained to sit on the river bank and interpret river observations, like rocks covered with algae may indicate nutrient enrichment; meandering rivers may cut into banks and deposit the eroded soil on a down river flood plain; certain macrophytes indicate water temperature and pH levels; riffle areas contribute dissolved oxygen to the aquatic ecosystem; and small concentric rings on surface water may indicate the site of emerging insects. These observations are often consistent with water quality data obtained with scientific water monitoring kits and systematic macroinvertebrate assessments. Aerial and satellite images are highly useful in monitoring watersheds to determine current and changing land use practices and the resulting impact on water quality; and cross-cultural partner watershed programs spark interest among involved schools worldwide.

Furthermore, there is an international need to develop a framework in which upstream nations understand implicitly the natural rights of downstream nations for a stable and unpolluted water supply. This calls for watershed action plans, and elements of such plan should recognize the importance of a basin-wide network system on monitoring of land and water systems for environmental quality; develop a network for monitoring and assessment of resources for environmental quality; instill environmental quality to sustain health and well-being of the watershed; and provide national planners with critical information necessary for making environmental sound decisions to increase sustainable development.

In a world where rivers no longer conform to political boundaries, respect for diverse cultural viewpoints created through effective cross-cultural communication forms the basis for better international

cooperation and action. As an international network that connects people from around the globe, GREEN provides students and teachers with opportunities to share their perspectives on teaching and learning about water quality and quantity concerns. (Wals, 1993).

An important component of GREEN is the ''Cross-Cultural Watershed Partners Program.'' This program was developed to provide a framework for sharing observations, knowledge, ideas, and solutions with people from diverse backgrounds. Typically, each participating school in this exchange program begins with steps developed in a GREEN publication: contacting and formalizing a cross-cultural relationship with the assistance of GREEN; preparing students for a cross-cultural exchange; developing pen-pal relationships; researching the historical background of one's river; monitoring the benthic macroinvertebrates and physical-chemical quality of the water; visualizing the desired condition of the local river at a time in the future; identifying the laws, policies and responsibilities of relevant regulatory agencies; developing and carrying out an action plan; and evaluating the program. Some GREEN partnerships include schools from the following nations (Stapp *et al.*, 1996d).

- Zambia–Kenya
- New Zealand–USA
- Spain–Peru
- Australia–Taiwan
- USA–Mexico
- Hungary–Canada
- Honduras–USA
- Russia–Sweden
- Italy–Brazil
- Japan–UK

Many environmental problems are caused by human activities, and education should be part of the process of changing attitudes toward a new system of thinking, new values, and new policies directed at improving the quality of human life. Education can be the instrument to change development into a sustainable future. International GREEN participants have helped to identify and clarify the following direction of the GREEN program.

GREEN's Mission

GREEN's mission is to improve education through a global network that promotes watershed sustainability. It is a resource to schools, communities, and businesses that wish to study their watershed and work to improve their quality of life.

GREEN's Goals

GREEN is an international network of people and institutions committed to actively improve and sustain the planet's land and water upon which all life depends. GREEN promotes attitudes, policies, and practices which encourage active participation by linking people at all levels through education, global communication, and cooperation. Programs are designed to foster environmental ethics, cross-cultural sensitivity and respect, thus contributing to a more trusting, caring, peaceful, and sustainable world.

GREEN's Strategies

GREEN is designed to promote watershed programs that are based on sound scientific analysis, values and action; support community-based education through local and regional partnership initiatives; develop model educational programs aimed at enhancing teaching and learning at the local level; create an educational environment in which empowerment for responsible environmental behavior can occur; provide leadership in the application of interdisciplinary, system-based watershed education; enhance communication and cooperation through a global network that promotes collaborative ties within and between communities; and provide mechanisms for greater accumulation of, and access to baseline environmental information on a national and global scale. Some other activities that have helped form GREEN's infrastructure over the past 12 years include the following.

GREEN Established a Quarterly Newsletter

The Newsletter is distributed to individuals and country coordinators in over 135 nations. The GREEN newsletter normally includes information from the director's desk, global perspectives, river stories, environmental education news, networking information, annual GREEN report, public workshop updates, and the annual report and financial statement. The GREEN country coordinators play a

critical role in sending information to the editor of the GREEN Newsletter and distributing the newsletter within their nation.

GREEN Promoted an International Computer Network

Watersheds provide a fertile environment for sharing perspectives, ideas, environmental information, and cross-cultural communication. Networking through telecommunication, especially using E-mail and the World Wide Web (WWW), allows students throughout the world an easy way to share watershed information and to participate in a global community. GREEN's WWW site http://earthforce.org provides information and pointers to watershed education resources elsewhere on the internet.

GREEN Developed Educational Technology Resources

Designed to improve access to technology, and to increase the opportunities for people engaged in watershed education projects to interact directly with one another in ways they find valuable, GREEN is developing a World Wide Web–based program for on-line exchange of standardized water quality data sets and off-line data analysis. In addition to recording raw sets the program allows participants to add field notes and information on monitoring methods and equipment.

GREEN Has Published a Series of Books

Publications include the *Field Manual for Water Quality Monitoring,* ed 12; *Sourcebook for Watershed Education; Investigating Streams and Rivers; Cross-Cultural Watershed Partners Activities Manual; Field Manual for Low Cost Water Quality Monitoring,* (ed. 2); *Environmental Education for Empowerment;* and *International Case Studies on Watershed Education; and Air Pollution: Ozone Study and Action.* All of these books are published by Kendall/Hunt Publishing Company, Dubuque, Iowa.

GREEN Collaborated With the LaMotte Chemical Company

The collaboration produced an innovative ''Global Low Cost Watershed Monitoring Program—Designed to Improve the Health of the Environment around the World.'' This program includes two ''Low Cost Kits,'' both involve non-hazardous tabletized chemicals, have a long shelf-life, and are inexpensive. One kit sells for US$28.00 (10 tests for each of eight parameters), and a second for US$159.00 (100 tests for each of eight parameters). The kits are simple to use, accurate, and non-hazardous, and will put information on local environmental quality into the hands of those who are most in need—local citizens. These Low Cost Kits are helping people on all continents become more familiar with their local watershed by exploring the impact of changing land-use practices on local rivers and water supplies.

GREEN Corporate Partnership Program

GREEN will be forging new partnerships with environmentally conscious corporations who want to involve youth in improving watersheds. This is an opportunity for corporations to create relationships with local nonprofits and schools, give employees an outlet to volunteer, invest in local youth, and improve the environment.

GREEN Sponsored the First National Student Watershed Congress

For 3 days this congress united students, teachers, and community partners who had worked together to ensure the well-being of local watersheds. School teams from across the country held seminars on how they had adapted the GREEN model to watershed education to their local settings, and emphasized the research and actions they had conducted on behalf of their watersheds. The congress gave participants the opportunity to highlight qualities of their local programs, while at the same time giving recognition to the successes, concern, and challenges they share.

GREEN Trained a Special Cadre of Workshop Facilitators

GREEN provides training to schools and communities globally. Through GREEN's research and development partnership, they have launched a series of new educational tools, training programs and curricular enhancement for environmental monitoring, data storage and management, and global commendation and collaboration.

GREEN—Australia (OzGREEN)

OzGREEN plays an important leadership role in GREEN-Asia/Southern Pacific. OzGREEN is dedicated to educational programs that are action-based; involves communities in watershed protection, links schools, industry, communities and governments; challenges people to embrace the environmental issues at all times (locally and globally); helps to bring about long-term change; and ensures that Australians are working as part of a global team to protect watersheds.

GREEN—Europe

GREEN—Europe was founded to help institutionalize GREEN programs in Europe. In Greece, during the summer of 1997, 22 European nations met and set the stage for the formation of GREEN—Europe to improve the sustainability of watersheds throughout Europe. GREEN—Europe has established its own office with program officers and Board of Directors to guide the GREEN—Europe operation. GREEN—Europe's web site can be reached through Earth Force/GREEN at http://www.earth force@earthforce.org.

FINAL REFLECTIONS

GREEN believes that teachers and students should play a major role in shaping their own education. Teachers' personal classroom experiences and insights are not tapped enough in designing good education. At the same time, students are often an untapped source of renewable energy and creativity with ideas and concerns of their own (Robottom, 1985).

The pedagogical model that GREEN has been working with is ''Action Research and Community Problem Solving'' (Wals *et al.*, 1990b; Stapp *et al.*, 1996a).

Action research was developed as a methodology by Kurt Lewin. He believed strongly in democratic decision making, a more equitable distribution of power, and that practical problems were a never-failing source of ideas and knowledge. Rather than asking for ''outside'' expertise of resolve existing disputes, Lewin involved the affected group in articulating, discussing, and eventually acting on a particular problem. Through analysis, conceptualization, fact-finding, planning, implementation, and evaluation—and then a repetition of this whole spiral of activities participants became engaged in a cyclical process of task resolution, marked by critical reflection and action (Kemmis, 1985).

Community problem solving comprises an approach to learning that focuses on resolving or improving local issues through a problem solving process. Community problem solving has its origin in the grassroots community's organized efforts to help groups concerned about local problems and conditions become more effective in accomplishing their goals. Important elements of community problem solving are: recognizing a problem; collecting, organizing, and analyzing information; defining the problem from a variety of perspectives; identifying, considering, and selecting alternative actions; developing and carrying out a plan of action; and evaluating the outcome and the entire process.

Action Research and Community Problem Solving (ARCPS) can be defined as a process that enables students and teachers to participate more fully in the planning, implementation and evaluation of educational activities aimed at resolving an issue that the learners have identified.

During the ARCPS process, students become the practitioners of their own education, taking on the role of explores, researchers, theorists, planners, and actors. Through the process, they come to assume more responsibility for their own learning. The teacher becomes the guide and facilitator in this process and shares the role of learner when reflecting upon his/her own teaching practices and when learning about the issue the students immerse themselves in during the action.

The ARCPS process is a well-rounded learning experience, for student and teacher alike, that allows a group of students and teachers to work jointly toward resolution of a problem of mutual concern. It is an attempt to empower learners by giving them a

say in their own education and by encouraging them to take actions, even on seemingly complicated tasks. ARCPS represents a systematic approach to learning aimed at providing learners the experiences and skills necessary to become confident and competent decision-makers in society.

Several key assumptions underlie ARCPS. First, it is crucial for society to solve critical issues with the full participation of its young members. Second, students need to know that they can be forces of constructive change, and that their involvement is indeed needed in the world. In other words, education should be geared towards substituting feelings of apathy and ''powerless'' with the feeling that one, be it as an individual or as a group, indeed can make a difference. Therefore, ARCPS emphasizes that students must be given more responsibility in the planning of educational activities and should be provided with the opportunity to take responsible action to improve the quality of their environment. Third, giving students a chance to investigate and act upon a problem of their choice will increase their motivation to learn. Lastly, the school and its community contain an untapped abundance of rich material for making education more meaningful to the students (Stapp *et al.*, 1996a; Bardwell *et al.*, 1994).

IN CLOSING: PAUL BRANDWEIN REVISITED

It was Paul F-Brandwein who planted a seed in my mind 35 years ago when he said that the teacher is not just a conveyor of knowledge, but a facilitator of learning. This learning, Brandwein felt, can only become meaningful when the educational system takes full advantage of community resources and the abilities of the students—where experiences feed knowledge, and knowledge feeds experiences; the known feeds the unknown, and the unknown catalyzes knowing (Brandwein, 1981).

My personal reflection is that Paul Brandwein was instrumental in helping me to explore the educational field for an instructional model for improving the teaching and learning climate in education. This process lead me, and other members of the GREEN community, to focus on Action Research Community Problem Solving as a suitable instructional model to meet the philosophy, mission, goals, and learning approaches of GREEN.

The field of environmental education cannot be seen as isolated from other emerging fields that focus on human rights issues, development issues, conflict issues and peace. Environmental issues, for instance, involve ethical questions regarding the sharing of the world's natural resources. As we look to the future, we need to take a closer look at issues of human rights, development, conflict, and peace (Wals *et al.*, 1993b).

It is important in education to involve people, including students, in the challenges of our time. Nobody knows the right ethical lifestyle, but we all have to be responsible for seeking a world which is built upon human equity and sustainable sharing of natural resources, not only between members of the western world, but the world as a whole.

GREEN is a program designed to bring individuals closer together and to encourage them to develop a sense of responsibilities for their communities and planet earth simultaneously. It is through direct learning experiences that students are more likely to recognize the relevance of science for improving their own lives, be able to adapt better to an increasingly technological world, and contribute to resolving science-technology-society issues responsibly. With GREEN,[3] the legacy of Paul F-Brandwein continues in the new millennium.

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[3]GREEN is a program under the umbrella of Earth Force: Earth Force, 1908 Mount Vernon Avenue, Second Floor, Alexandria, VA 22301; Tel: 703-299-9400; FAX: 703-299-9485; World Wide Web site: http://www.earthforce.org.

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