PHYTOREMEDIATION OF LEAD IN CONTAMINATED SOIL: BASIS FOR PUBLIC POLICY

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Abstract - The translation of scientific data into public policy would define them as valuable contributions with social and economic value. Use of scientific knowledge into public policy allows for it to be shared in a comprehensible form. This is the case of the phytoremediation of lead using Sesbaniagrandiflora L. as the basis for a municipal ordinance in Bulakan, province of Bulacan in the Philippines. The Marilao-Meycauyan-Obando river system also known as MMORS has been considered one of the dirtiest in the world. Bulakan's river is a tributary of the MMORS. The information on the heavy metal contamination of soil samples was the basis for the drafting of a municipal ordinance by Bulakan. The ordinance was drafted and approved using the public policy-making cycle. The ordinance started its course as a public policy in 2012. It was successfully established as an ordinance in 2015. By 2016, the policy was implemented thru the government supported projects and assisted by the university. In 2017, it was determined by the municipal officials that the ordinance required a more robust system to sustain the Sesbaniagrandiflora L. planting. The municipal social welfare and development officer utilized the ordinance as a tool for encouraging single parents to participate in its social reform program. It encourages single parents to participate in community programs that aim to preserve the natural and social environment. Their participation allows them to be eligible to a financial assistance program. Although the planting is favorably sustained, the growth of the Sesbaniagrandiflora L. plants face the challenge of enduring climate effects and human intervention.

According to an evaluation of the land planted with Sesbaniagrandiflora L., only 40% of the original plants remain undisturbed and allowed to flourish. Based on the evaluation, the reasons contributing to the 60% loss are; (1) destruction by humans; (2) clearing operations of home owners; (3) reclamation attempts near river banks; and (4) general lack of knowledge on the benefit of Sesbaniagrandiflora L.to environmental protection and restoration. An appropriate intervention program that would address the information and education campaign is necessary. The intervention program through an information and education campaign is a university-based strategy with a set monitoring and evaluation in place. Corrective measures are also established to address all constraints that may arise in the course of implementation. The university would publish a children's book on the story of the Sesbaniagrandiflora L. and how it helped in the preservation of the environment. This is a unique feature of the intervention program as it deals with a sustainable community-based activity.

Keywords - Phytoremediation, Sesbaniagrandiflora L., public policy

I. INTRODUCTION

The translation of scientific data into public policy is a challenge for the academe. Many scientific studies are yet to gain a foothold in public policy. Use of scientific data in policy-making would define them as valuable contributions with social and economic value. Science endeavors to generate a knowledge creating system that must be translated into practice. Use of scientific knowledge into public policy allows for it to be shared in a comprehensible form. This is the case of the phytoremediation of lead using Sesbaniagrandiflora L. as the basis for a municipal ordinance in Bulakan, province of Bulacan in the Philippines.

Phytoextraction is the use of vegetation and its associated microorganisms, enzymes, and water consumption to contain, extract or degrade contaminants from soil and groundwater [1]. The Marilao–Meycauyan-Obando river system also known as MMORS has been considered one of the dirtiest in the world. As such, it has been the subject of many environmental programs. Blacksmith Institute, a nonprofit environmental facility has undertaken several studies that deem the water from MMORS to be undrinkable and the freshwater fishes to be contaminated with heavy metals. Fish species from the river are contaminated with copper and zinc and that these are above the acceptable limit [2]. The prevalence of many heavy metals in the river water is an indication that the metals have accumulated in the soil nearest to the river.

Soil samples collected from the riverbanks of MMORS that are positive for lead were used in determining the phytoextraction of SesbaniagrandifloraL.. The study showed Sesbaniagrandiflora L. has phytoextraction potential that decreases the amount of lead from contaminated soils. Hoffnagle [3] notes that accumulation of lead in plants has been most successful over the years. This was conducted by the author in 2013.

Bulakan's river is a tributary of the MMORS. In 2011, the author was tasked by the municipal administrators of Bulakan to assist in the investigation of the causes of the dark, putrid waters in the town's river. The results from that initial analysis yielded high levels of chloride. Based on the standards set by the Department of Environment and Natural Resources (DENR), the regulatory agency of the Philippine

government in water resources, high chloride values would yield heavy metals in a few years. The chloride in water would lead to the corrosion of metals that would eventually produce heavy metal leachate. These results led to the conclusion that the Bulakanriver was under serious environmental threat. The town may suffer the ill effects of heavy metal contamination the same way that the adjacent towns of Marilao, Meycauayan and Obando are going through.

The information on the heavy metal contamination of soil samples called for an immediate review of possible control measures to contain the environmental threat. The results of the study on the phytoextraction of Sesbaniagrandiflora L. were presented. On the basis of the results and upon the recommendation of the author, planting of Sesbaniagrandiflora L. would counter the possible contamination of the water and soil by heavy metals. The study [4] was the basis for the drafting of a municipal ordinance by Bulakan. A more thorough process of drafting the document as basis for public policy was undertaken by the university and the municipal administrators. The ordinance was drafted and approved using the public policy-making cycle used by Bernstein (2017).

II. PROCEDURE FOR POLICY MAKING

A. Agenda Setting

Following the results of the river water analysis in 2011, wherein high chloride values were determined from water samples. It was deduced based on published by the DENR that high chloride values would yield heavy metals in water that may settle in soil in a few years. The Sangguniang Bayan (municipal legislative body) of Bulakan headed by Vice Mayor Alberto Bituin proposed the determination of environmental preservation strategies in its systemic agenda in 2012. A systemic agenda notes all possible issues that may arise in proposing the policy. Authorities in this field may address the issues thru consultation.

In 2013, the results of the study on the phytoremediation of Sesbaniagrandiflora L. were disclosed to the administrators of the municipal government of Bulakan. The Sangguniang Bayan (SB) then elevated the environmental preservation strategies into an institutional agenda. An institutional agenda is drafted based on the results of the consultations from a systemic agenda. It was specified that the strategy be defined specifically as the use of Sesbaniagrandiflora L. to decontaminate polluted soils. The members of the SB were able to address all possible issues and determine corrective measures to facilitate the drafting of a sound policy that is meant to protect the water and soil in Bulakan.

By 2014, the use of Sesbaniagrandiflora L. to decontaminate polluted soils was finally included in the decision agenda. A final list of issues was drawn prior to the next step in policy-making. A draft of the ordinance was prepared on April 2014 by the author and sponsored by Municipal Councilor Piccolo IñigoMeneses. The ordinance was set for the next phase of the cycle.

B. Policy Formation

By June 2014, the first reading of the ordinance was held by the SB with the author present as the technical expert. Members of the SB, barangay captains (village heads), school administrators, municipal employees, and private citizens were present to discuss the issues regarding the environment and public health. Issues on implementation, budget requirements and evaluation and monitoring were discussed, addressed and resolved. On June 2015, the final public hearing was held and was then resolved that the municipal government would adapt the ordinance.

C. Policy Legitimation

In August 2015, the Phytoremediation and Ecosystem Restoration Ordinance was formally signed by the members of the SB. Its full implementation according to its rules and regulations was undertaken that same year on a project headed by the administrators of theMunicipal Government of Bulakan.

D. Policy Implementation

By 2016, several projects on planting of Sesbaniagrandiflora L. have been undertaken in cooperation with Bulacan State University. The planting of cuttings near river banks was part of the community outreach of the university that manifested its support to the ordinance that was created from its research study.

E. Policy Evaluation

By 2017, the municipal administrators evaluated the policy and have concluded that the ordinance required a more robust system to sustain the Sesbaniagrandiflora L. planting. In addition to the community outreach programs of the university, the municipal social welfare and development officer utilized the ordinance as a tool for encouraging single parents to participate in its social reform program. It encourages single parents to participate in community programs that aim to preserve the natural and social environment. Their participation allows them to be eligible to a financial assistance program.

F. Policy Maintenance, Success or Termination

The university maintains its support to the implementation of the ordinance through the supply of Sesbaniagrandiflora L. cuttings. However, the unique program of the municipal social welfare and development officer in encouraging single parents to participate in its social reform program earned the

municipal government the Best Practices award for social reform. Upon evaluation, the implementation of the ordinance has acquired a substantial level of success.

III. RESULTS

The Phytoremediation and Ecosystem Restoration Ordinance hasattainedfull implementation because of the social reform program set in place by the Municipal Social Welfare and Development Office. However, it is not devoid of challenges. Although the planting is favorably sustained, the growth of the Sesbaniagrandiflora L. plants face the challenge of enduring climate effects and human intervention.

According to an evaluation of the land planted with Sesbaniagrandiflora L., only 40% of the original plants remain undisturbed and allowed to flourish. Based on the evaluation, the reasons contributing to the 60% loss are; (1) destruction by humans; (2) clearing operations of home owners; (3) reclamation attempts near river banks; and (4) general lack of knowledge on the benefit of Sesbaniagrandiflora L.to environmental protection and restoration.

In view of the reasons cited for the lack of opportunity for the Sesbaniagrandiflora L. plants to flourish, several steps were needed to be taken to educate and inform the residents of Bulakan on their benefits. An appropriate intervention program that would address the information and education campaign is necessary.

The intervention program consists of a video presentation on the benefits of Sesbaniagrandiflora L. to the villages. Video presentations to be spearheaded by the university through the support of the municipal government have been scheduled. A kick-off activity was among the identified strategies to increase the awareness of the residents of Bulakan.

On a more sustainable level, the university would publish a children's book on the story of the Sesbaniagrandiflora L. and how it helped in the preservation of the environment. This is based on the theory that school-aged children grasp concepts more effectively in the form of stories or tales. It is believed that this enables them to become effective is sustaining environmental preservation and restoration. The book will be read by university faculty to grade school children, which will be followed by a draw-and-tell activity. This would ingrain the concepts on the development of the children.

CONCLUSIONS

The need to educate and inform residents on the benefits of a public policy confirms the cyclical lifespan of every science and policy-making collaboration. Public policies may dictate the implementation and evaluation, but science determines the course of its sustainability based on objective evaluation. The intervention program through an information and education campaign is a university-based strategy with a set monitoring and evaluation in place. Corrective measures are also established to address all constraints that may arise in the course of implementation. The children's book is a unique feature of the intervention program as it deals with a sustainable community-based activity.

RECOMMENDATIONS

Periodic monitoring of the growth of Sesbaniagrandiflora L. plants be conducted to determine the extent of implementation of the municipal ordinance.

Determination of the effects of the intervention program through an information and education campaign should be measured.

The children's book as a sustainable community-based activity should be used in other municipalities in the province to gain a wider audience and be effective as a tool for community development.

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