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The Preparation of a Protocol for
Epidemiological and Socioeconomic Investigations
of Biostabilization Pond Effluent Use for Irrigation,
San Juan de Miraflores, Lima, Peru

Pan American Center for Sanitary Engineering and
Environmental Sciences (CEPIS)

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Lima, Peru

by

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Epidemiological and Socioeconomic Investigations of Biostabilization Pond Effluent Use for Irrigation, San Juan de Miraflores, Lima, Peru

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BACKGROUND

Since 1977, the Pan American Center for Sanitary Engineering and Environmental Sciences (CEPIS) has conducted a series of investigations on the San Juan biostabilization lagoons and the reuse of the effluents for irrigation agriculture and pisciculture. The objectives of the investigations are to demonstrate the feasibility of introducing health and sanitation controls in biostabilization pond design so as to produce, on a large scale, a quality of effluent which may be used to:

1. recuperate desert land for agriculture and forestry;
2. produce food of high sanitary quality;
3. create opportunities for new settlements and employment;
4. increase opportunities for recreation and other amenities by the creation of parks and green areas; and
5. solve the problem of the final disposal of sewage produced by the city of Lima, which otherwise would be channelled out to sea, contaminating it.

Further investigations of the San Juan pond effluent reuse are required particularly of the epidemiology, socioeconomics, microbiology and toxicology of irrigated vegetable cultivation. Once complete, these studies will provide the basis for the design, construction and operation of stabilization ponds to irrigate 5,000 ha. of desert at San Bartolo to the southeast of Lima.

As CEPIS does not have specialists in these areas, a meeting was planned to take place from 9-27 January 1984, to convene an international working group for the purpose of designing the epidemiological and socio-economic investigations. Moreover, this endeavor was conceived of as
a joint CEPIS-ECO project and Dr. Schorr was asked to participate and contribute to the behavioral and socioeconomic components of the investigations.

Because of financial circumstances, ECO was advised in CEPIS telex 306-UT of 16 November 1983 that the original meeting plans were cancelled, but Schorr was still requested to visit beginning late-December to proceed "with basic idea to formulate project and prepare proposal ..." The complete terms of reference for this collaboration are detailed in Annex I.

ACTIVITY

Dr. Schorr arrived in Lima late Friday evening 30 December 1983 and remained until early Saturday morning, 21 January 1984. During this time he worked principally with Drs. Carl Bartone of CEPIS, and Branko Svjetanovic, STC, formerly WHO epidemiologist. Drs. Svjetanovic and Schorr made a number of field trips to the San Juan zone of influence, met with the Peruvian counterpart investigators and others listed on p.4 of Annex I, and visited agricultural zones in the vicinity of the Río Rimac where untreated sewage is being used for crop irrigation. Dr. Schorr initiated contact with Dr. José Matos Mar, renowned Peruvian social anthropologist, Director of the Instituto de Estudios Peruanos, and expert on the processes of urbanization of the city of Lima. Dr. Matos Mar agreed to manage the behavioral, social and economic aspects of the investigations, in collaboration with Drs. Bartone, Schorr, and the other multidisciplinary investigators.

RESULTS

Drs. Svjetanovic and Schorr drafted "Considerations Related to the Proposal ..." (Annex II, 30 pp.), "A Protocol for Epidemiological and Socioeconomic Investigations ..." (Annex III, 24 pp.) with two annexes on the epidemiological census (I, 4pp.) and "Methods for the Evaluation of Behavioral Practices, Sociocultural Characteristics and Economic Activities" (V, 12 pp.). These documents and the formation of the investigative group responsible to undertake the studies represent the major accomplishments of this consultation. The participating co-investigators have agreed to draft their respective annexes to the protocol, which will also result in a proposed budget for the entire study. Dr. Bartone will pursue avenues of interest in acquiring the funds for the investigation. Dr. Schorr remains ready to continue collaboration as outlined in the Protocol (pp. 18-19).
ACKNOWLEDGEMENTS

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ANNEX I

EVALUACION EPIDEMIOLOGICA Y SOCIOECONOMICA DEL
PROYECTO DE REUSO DE AGUAS RESIDUALES TRATADAS PARA RIEGO-SAN JUAN

Diciembre 1983 - Enero 1984
CEPIS/Lima

INTRODUCCION

El CEPIS a partir de 1977, ha participado en la realización de una serie de investigaciones sobre las lagunas de San Juan y el reuso de sus efluentes tratados para agricultura y piscicultura.

El objetivo principal de estos estudios ha sido obtener un mejor conocimiento de los posibles efectos sanitarios del reuso y plantear medidas de control sanitario requeridas para proteger la salud pública.

Las investigaciones han considerado aspectos tales como la evaluación de la eficiencia del tratamiento de las lagunas de San Juan para la estabilización de desechos orgánicos, y la remoción por procesos naturales de organismos patógenos incluyendo bacterias (por ejemplo, coliformes fecales y salmonella) y parasitos. También se ha analizado la calidad sanitaria de los efluentes utilizados para riego y piscicultura.

Los resultados demuestran que el tratamiento en las lagunas es eficiente, y que con una operación adecuada de tres lagunas en serie se puede obtener efluentes que cumplen con las normas de calidad exigidas para estos usos con respecto a parasitos y bacterias indicadoras.

Las investigaciones anteriores han sido desarrolladas con el apoyo de la Dirección General del Medio Ambiente del Ministerio de Salud del Perú, y el financiamiento del Centro Internacional de Investigaciones para el Desarrollo de Canadá, y el Banco Interamericano de Desarrollo.

Actualmente el CEPIS forma parte de un grupo nacional de instituciones investigadoras que se han reunido para estudiar la viabilidad técnica, económica y sanitaria de piscicultura en lagunas de maduración alimentadas con los efluentes tratados de San Juan. Se está cultivando peces y camarones. Al CEPIS le corresponde vigilar la calidad del agua, tanto para patógenos como para amoníaco y detergentes, dos compuestos químicos que son potencialmente tóxicos para peces aunque no representen ningún peligro para el ser humano.

Otras investigaciones por iniciarse en 1984 incluyen el estudio de posibles efectos de contaminación de las aguas subterráneas debido a infiltraciones de las lagunas y campos de riego (Dr. Stephen Foster, ODA), y la evaluación sanitaria de la producción de la lenteja de agua (lemna trisulca) en las lagunas y su utilización como alimento para aves de corral (Dr. Paul Skillikorn, Univ. Johns Hopkins).
La importancia de estas investigaciones para el país es múltiple; permite establecer controles sanitarios adecuados para reuso en una escala más grande; contribuye a resolver un problema de producción y de calidad sanitaria de alimentos y por ende nutrición; recupera tierras desérticas para la agricultura y reforestación; crea empleo y oportunidades de asentamiento; aumenta oportunidades para recreación y otras amenidades mediante la creación de parques y áreas verdes; y soluciona un problema de disposición final de las aguas residuales de Lima, que de otra manera se vacían al mar así contaminándolo. Estos beneficios indican que el reuso puede ayudar a financiar en parte obras de tratamiento de aguas residuales.

Otros beneficios indirectos son que a través de estos proyectos de investigación se ha formado un grupo grande de investigadores nacionales jóvenes quienes podrán seguir contribuyendo al desarrollo del país en el futuro; se han producido manuales didácticos; y se han establecido nuevos criterios de diseño para lagunas de estabilización.

Como resultado de estas experiencias el Perú está realizando un estudio de factibilidad para recuperar 5000 Ha. de desierto en San Bartolo y regarlo con unos 5m³/s de desagües de Lima. El proyecto de San Bartolo cuenta con el financiamiento del BID y posiblemente el Gobierno del Japón.

**OBJETIVO**

Como complemento a las investigaciones ya hechas e insumo importante al estudio de factibilidad de San Bartolo, todavía hace falta una evaluación de los impactos epidemiológicos y socioeconómicos del proyecto de reuso de San Juan, y su comparación con el reuso no controlado que ocurre frecuentemente en Lima.

Los objetivos de esta investigación serían:

1. Efectuar un estudio comparativo de la calidad bacteriológica y toxicológica de productos de panlevar de San Juan versus productos de otros sitios en Lima de reuso con desagües crudos.

2. Realizar una encuesta sociológica con el fin de delinear las redes económicas asociadas con proyectos de reuso y evaluar sus consecuencias sociales.

3. Llevar a cabo un estudio epidemiológico de las poblaciones afectadas - incluyendo los trabajadores sanitarios y los agricultores y sus familias, además de la población consumidora de los productos (identificados en el punto 2). Se establecerán controles adecuados para evaluar su situación vis-à-vis poblaciones similares de proyectos no controlados de reuso y de la población general.

**GRUPO ASesor**

Ya que el CEPIS no cuenta con especialistas en epidemiología, sociología y microbiología y toxicología de alimentos, se ha decidido organizar un Grupo Asesor
para colaborar en la formulación del proyecto y en el desarrollo de una propuesta definitiva de investigación. En el Grupo Asesor participarán expertos en los temas antes mencionados, de la OFS y consultores externos invitados, además del equipo de investigación de San Juan del CEPIS y profesionales locales.

Los miembros del Grupo prepararán las bases metodológicas en sus sedes respectivas durante diciembre y viajarán (caso de expertos internacionales) como asesores temporeros a Lima a fines de diciembre o inicios de enero con el fin de preparar la propuesta definitiva. El CEPIS proveería sus consultores, facilidades físicas, transporte local y apoyo de secretaría.

**PROPUESTA DEFINITIVA**

La propuesta definitiva para la investigación será preparada por los miembros del Grupo Asesor, dando especial énfasis a los siguientes puntos:

- La selección de los sitios de reuso a ser investigados;

- La identificación de las poblaciones afectadas;

- La elaboración del programa de muestreo y análisis para determinar la calidad sanitaria de los productos de panlevar, incluida la especificación de los métodos de muestreo y análisis microbiológico y toxicológico a ser aplicados;

- El diseño de la encuesta sociológica para delinear las redes económicas asociadas con los proyectos de reuso y evaluar las consecuencias socioeconómicas del reuso, incluido el prediseño de los instrumentos para la encuesta;

- La elaboración del protocolo de un estudio epidemiológico experimental para evaluar el efecto de reuso sobre la salud de la población trabajadora y consumidora, incluyendo prediseño de los instrumentos y metodologías para la recolección de datos, la especificación de la población de control y de los métodos de análisis de datos a usarse;

- La consideración de los aspectos éticos de la investigación;

- La identificación de instituciones locales quienes podrían desarrollar los estudios, y de consultores especializados;

- La preparación de términos de referencia para contratación de estudios o consultores;

- La identificación de requisitos de entrenamiento para los investigadores y personal del proyecto;

- El esbozo de un plan para la diseminación y aplicación de los resultados de la investigación, incluyendo seminarios y publicaciones;
- La elaboración de un presupuesto detallado incluyendo personal, consultores, servicios contractuales, equipos y suministros, entrenamiento, viajes y per diem, procesamiento de datos, gastos operacionales, seminario de difusión, informes, gastos de administración, etc., identificando claramente contribuciones externas requeridas y contribuciones locales de contraparte,

- El desarrollo del plan de trabajo detallado con cronograma.

La propuesta resultante del esfuerzo del Grupo Asesor será presentada a alguna agencia multi o bilateral para su financiamiento.

Se espera que los asesores también den seguimiento y asesoría al estudio en sus varias etapas de desarrollo.

PARTICIPANTES

 Una lista tentativa de los participantes en el Grupo Asesor sería la siguiente:

OPS:

✓ - Dr. Thomas Schorr, BCO
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✓ - Biolq, Carmen de Mayo, CEPIS
✓ - Quím. María Luisa de Esparza, CEPIS
✓ - Dr. Milton Arnt, Epidemiólogo, Perú
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✓ - Ing. Juan Zapater, Universidad Nacional Agraria
✓ - Dr. Miguel Campos, Universidad Peruana Cayetano Heredia

Invitados Extranjeros

✓ - Dr. Donald Sharp, CIID
✓ - Dr. Barry Lloyd, Universidad de Surrey (Investigador Visitante, CEPIS)
CONSIDERATIONS RELATED TO THE PROPOSAL FOR AN EPIDEMIOLOGICAL AND SOCIO-ECONOMIC INVESTIGATION OF THE TREATED SEWAGE IRRIGATION PROJECT

SAN JUAN DE MIRAFLORES, LIMA

Branko Cvjetanovic
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CENTRO PANAMERICANO DE INGENIERÍA SANITARIA Y CIENCIAS DEL AMBIENTE (CEPIS)

Lima, Peru
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1. The Problem

The first step was to define the problem to be addressed. "Multiple benefits for the country can derive from ... large scale reuse projects; contributions to protein production and improved nutrition; the recovery of desert land for agriculture and creation of employment and settlements opportunities; and development of viable alternatives to the ocean disposal of Lima's sewage and the corresponding beach pollution problem". Similar projects are multiplying in Peru and are becoming one of the important tools for socioeconomic development. CEPIS has made excellent progress in developing appropriate technology for reuse of treated effluents for irrigation and aquaculture.

Economic and health benefits being obvious, the problem the study has to elucidate was considered by CEPIS to be (a) whether there are health risks, primarily those related to the spread of water- and food-borne diseases, endangering the health of the workers engaged in such projects; the agricultural workers using the effluents, and the project population consuming agricultural and aquacultural food products, and (b) which direct health benefits have been derived from the project (such as better nutritional status) and which indirect health benefits come as the result of socio-economic improvements.

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The problem could be viewed as a research problem related strictly to the San Juan project, or in a much wider context as a problem of many similar present and future projects in Peru, which will increase in number and in population coverage, and will require permanent monitoring of the risks and a continuous effort to increase the benefits.

Besides variations related to the definitions of the problem and the scopes of the study there were also several alternative approaches to the epidemiological and socio-economic evaluations of the health impacts of the San Juan effluent reuse project specifically, and to wider, general aspects of health impacts of effluent reuse in Peru. These alternative approaches also differed in their cost and feasibility. Last but not least they differed in their relevance to the practical problems of the potential usefulness of the results of the study in further development of effluent reuse projects and in increasing their health and socio-economic benefits.

2. STUDY DESIGN

2.1 The purpose

Since CEPIS has solved technological aspects of the treatment of effluents for agricultural purposes and demonstrated its bacteriological safety by laboratory tests it was considered that the purpose of the study should be to assess, by epidemiological investigations of the population involved in the project (sewage treatment workers, agricultural workers and their families as well as the consumers of food products) the health impacts, the risks of enteric infectious diseases transmission and health benefits derived from better nutrition and socio-economic improvements. It was also...
considered that besides the San Juan project population there should be
similar population groups found who (a) use raw sewage and (b) those who are
not exposed to use of sewage at all. The study therefore was envisaged by
CEPIS as a study of large population groups for a relatively short period of
time; a study of a cross-sectional, epidemiological and socio-economic survey
type aimed at comparing samples of the populations exposed to (a) treated and
(b) untreated sewage and (c) a control group free of such exposures as far as
the incidence of enteric infections and their health status is concerned.

Additionally, the purpose of the socio-economic part of the
investigation was described as being "to delinate the economic networks
associated with reuse projects and evaluate its social consequences."

2.2 Terms of references

The above description of the purpose of the contemplated study actually
represented basic terms of reference for the group of advisers who met to
formulate the protocol for the study for submission to CEPIS, and eventually
to granting organizations.

2.3 Opportunities and constraints

2.3.1 Opportunities: The results of CEPIS's studies on effluents
containing information on parasitic and bacterial pollution of
raw sewage and the quality of effluent were reviewed and it was
found that they represent an excellent starting point and
opportunity for the future studies. Extensive use of various
systems of irrigation with sewage in Lima represented another
important opportunity for the proper study design.
The absence of any socio-economic information, aside from hearsay, about the households using the treated effluents of the stabilization ponds likewise presents both opportunities as well as constraints. These investigations represent an opportunity to produce baseline information of importance in understanding the health and socio-economic dynamics of treated effluent reuse by a population which spontaneously established itself and apparently has been functioning successfully for almost 16 years.

To determine if the population would be receptive to being studied, visits were made to squatters' households, selected by convenience of access, and the adult present in charge of the household was interviewed in a quasi-structured, open-ended manner to learn such basic things as the length of residence and cultivation, size of family, variety of farm products, ideas about the use and relative contamination of the effluents, sources of drinking water, and so on. During the course of the interview, inquiries were made to find out; a) if the effluent users perceived the necessity of undertaking an epidemiological and socio-economic investigation among them, and b) would cooperate with it; and in particular, c) could they perceive of deriving sociocultural and economic benefits from the study.²³

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The preliminary indications turned out to be positive in both of the above concerns. The residents who were interviewed expressed that their presence and activities were not understood and unappreciated for the benefits they were producing as farmers making use of the available wastewater. They felt that whatever information resulting from a study of their condition would be of benefit to them because it would lead to a favorable resolution of their precarious land tenure situation and help to establish a legal basis for their continued occupancy of their lots and the use of the effluents. Based on the possibility of a favorable outcome, their cooperation in the study could be expected.

Last but not least, the presence in Lima of well equipped and staffed research institutions with excellent technical knowledge and abilities which could assist CEPIS in the contemplated study, represented a guarantee for the high quality of the research work.

2.3.2 Constraints:

However there were several constraints some of which were immediately evident while others became apparent later, following site visits to the stabilization ponds, preliminary interviews with some of the farm families and further explorations with other members of the team in the course of working out an appropriate study design.

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The epidemiological data, namely on incidence and prevalence of enteric diseases, contrary to excellent microbiological information were obviously suffering from inadequacies of health services resulting in high under reporting. Therefore the need to set up a separate group for epidemiological investigations was obvious, as it would be unrealistic to expect that existing health services could quickly upgrade the efficiency and quality of the reporting and their epidemiological work. The cost of such undertaking was also seen as an important constraint.  

The consumers of food products population group were difficult, actually impossible to define due to extremely varied food marketing systems applied in Lima through middlemen of all kinds, retailers, street food vendors and restaurants in a mushrooming city subject to continuous invasions of immigrants from various parts of Peru.

However, it may be premature to conclude that consumers cannot be identified. The results of the random interviews of household representatives indicate that in recent years following the settlement of nearly Villa Salvador, residents began to buy directly from the farmers. This practice continued to increase until by now, all of the produce from the farmers living and cultivating in the immediate vicinity between the ponds and the park, is sold to Villa Salvador people. On initiating the study

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an attempt should be made to identify consumers of the produce to
determine if they may be included as a valid part of the study
population.

The population of the effluent reuse project in San Juan which
will receive intensive study numbers about 125 persons, this is
too small for any precise determination of incidence rates of
various enteric infections e.g. typhoid, hepatitis A, etc.

Other population groups (using effluents, or not exposed to them)
which could be used for comparison and as a control group were
too different from the stable population of settled agricultural
families in San Juan so that it may be unrealistic to consider them
as being really comparable. For example, the use of untreated
effluents from the San Juan ponds continues to the south of the
park, but three factors complicate the inclusion of those user
populations in the study (a) the land is cultivated
cooperatively, using hired farm laborers whose families do not
inhabit the land, (b) untreated sewage from Villa Salvador is
being used to irrigate, extending a cultivated area toward the
outer reaches of the San Juan effluents, and (c) it appears as if
the principal crops are not for human consumption but provide
fodder for the local pig industry.

Fully

Neither could justification be found to include the eight male
pond site attendants in the socio-economic study. The only thing
they have in common with the effluent users is that they come
into contact with it. Otherwise they share no other
socio-economic characteristics and are not affected by the
socio-economics of the effluent users. They are hired, salaried
employees having social security, retirement and other fringe benefits. Their status is fully legal, unlike the squatters using the water who are in a precarious position and are legally classified as "evicted" ("desalojados"). Moreover, the families of the pond attendants do not live at the site and hence, are not exposed to the effluents. Although the socio-economic characteristics of the eight site attendants could be undertaken, it would require a separate study design and would be difficult to justify because of its cost. However, the health status of the pond attendants may be easily determined by other study sectors of the protocol and this is recommended.

Even so, none of these aspects defining the population should be taken as absolute restrictions and the study design cannot be considered final in this respect until a systematic, preliminary, socio-economic survey is made of the area and a final definition of the study population is made.

2.4 Study design

The study design was approached following the terms of reference namely the purpose of the study as conceived by CEPIS. It was only after various alternative approaches to the study design were explored that those which were inappropriate were abandoned and the final study design proposed. However in this process we departed gradually from primarily fixed purposes and developed our own terms of reference based on considerations of the opportunities and
constraints presented earlier. We explored new approaches for obvious reasons: assuming a small size for the study population, this imposed; (a) replacement of cross sectional type of the study with the longitudinal one; (b) replacement of specific enteric diseases as indices, with large groups of frequent infections such as diarrhoecal diseases and health and nutritional indices which can be applied to every member of the community; (c) a shift in the socio-economic methodology from the use of questionnaire and sampling techniques, to more intense observation - enumeration - description methods, with quantified measures applied to the entire population whenever possible, such as in the calculations of energy inputs, flows, outputs and exports; household budgets, and resources usage in general. The small population also makes possible the longitudinal study of individual and family life cycles, through life history interviews.

As mentioned earlier, socio-economic investigation has the broadly stated objective to "deliniate the economic network associated with reuse projects and evaluate its social consequences". This objective was subsequently redefined with greater precision as the combined protocol of the epidemiological and socio-economic investigations was developed. The socio-economic investigation has been subdivided into three components to facilitate data gathering and analysis: 1) the behavioral practices of the study population which may affect its health status and productivity; 2) the

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7= CEPIS, "Evaluación epidemiológica y socioeconómica del proyecto de reuso de aguas residuales tratadas para riego - San Juan" (revised 21/XII/83). Lima; Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente.
socio-cultural characteristics which define the population and the way it operates; and 3) its economic status in the context of the foregoing, and with respect to its satisfaction of basic needs, its capacity to sustain an acceptable level of health and well-being, and to contribute productively to national life and economy.

3. ALTERNATIVE EPIDEMIOLOGICAL APPROACHES

3.1 Epidemiological evaluation of the San Juan project

This study obviously had to be conceived of as an investigation of high research quality to match the excellent engineering and bacteriological work already done in San Juan by CEPIS.

3.1.1 The first approach considered was to concentrate on microbiological field and laboratory studies of the safety of the San Juan effluents, and thus on the safety of the food products. It was considered that should these studies lead to the conclusion that there are no unacceptable risks of infections involved, there would be no need to proceed with an epidemiological evaluation of the spread of enteric infections in populations consuming San Juan food products. Detection of pathogenic microorganisms or indicator organisms in the raw sewage, followed by the evidence of their elimination from final effluents was considered to be an adequate guarantee
of safety. Such an approach would require a continuation of the excellent investigations done by CEPIIS on intestinal parasites and enteric bacteria which initially proved effluent safety ⁹ ⁸. Since however these earlier studies do not preclude the absence of viruses in effluents, the investigations therefore should extend to important enteric viruses as indicators (e.g. polio, echo, coxsackie, hepatitis A virus – one of the most important viruses which requires special attention in particular; studies of this virus are going on at the Navy Hospital virological laboratory).

(Isolation of viruses requires that a certain amount of water be filtered, appropriate filtering apparatus, supplies and skill ⁹ ¹⁰. It might therefore save time, funds and effort if suitable shellfish species such as oysters or mussels from


clean water (or "cured" in clean water) could be put for 1-2 days in the treated effluents where they would filter a sufficient quantity of water for the purpose of the study. Thus, concentrated viruses in the shellfish could then be easily isolated, \textsuperscript{11, 12} after removing non-viral contaminants with antibiotics).

(An observation of the wild ducks' preference to swim in ponds with untreated effluent, and possibly of other birds' preference for cleaner effluents might offer an opportunity to study the presence of Salmonella in their eggs. A study of this type could be extended also to the problem of the inefficacy of the elimination of Salmonella and other microorganisms by boiling or frying the eggs, which in common practice is done inadequately. The microbiological techniques could be kept continuously under review and improved as the new techniques become available. Technical advice from an experienced environmental virologist for sampling enteric viruses and hepatitis A virus\textsuperscript{4} would be useful.


3.1.2 The second approach considered was to follow up, through existing primary health care and existing super structures of health services, infant mortality, specific mortality and morbidity due to enteric infections in well defined study* and control** groups. With improvements of the population coverage and better recording it should be possible to have as the basis for comparison of these groups following indices:

- infant mortality: general and due to enteric infections;
- specific mortality of all ages due to enteric infections;
- specific morbidity, incidence of major enteric infections;
- "excess mortality" due to enteric infection in children 0-4 and 5-19 on weekly basis. (This method was used in many countries for the study of outbreaks of influenza and respiratory infections but can be adapted to enteric infections where and when these are severe, seasonal and frequent).

The above data when collected however, would neither prove nor disprove that enteric infections were caused by reuse of effluents because in Peru there are many carriers, sources and vehicles of infections. However should the introduction of effluents reuse in a community be followed by increased specific mortality and morbidity this would point to having been caused by the usage of food contaminated with unsafe effluents.

* group(s) composed of sewage workers, agricultural workers (and their families) and the consumers of the respective food products coming from areas using treated effluents and another similar area using untreated sewage for irrigation

**group(s) similar to above study group(s) in all other aspects except the use of effluents and the food thus produced.
"Excess mortality" due to enteric infections would facilitate epidemiological enquiries and notification. Obviously, a detailed study protocol should give clear definitions of the groups to be studied, the methods of diagnosis, the definition of disease(s) and methods of recording and data analysis.

3.1.3 The third approach considered was to develop much further all aspects of the study mentioned above (3.1.2) and to do in addition the epidemiological investigations of the transmission of enteric infections aimed at the elucidation (whenever possible) of the mode of transmission. For obvious reasons cases of e.g. typhoid among people in the effluent using community might also be due to other sources of infection than effluents. Such investigations would therefore require intensive coverage of study and of control populations by skilled epidemiologist(s) and auxiliaries with necessary transportation facilities, communications, laboratory support and last but not least an effective data storage and processing facility. In spite of all efforts, technical support and excellence of epidemiologist(s) in a city like Lima where there are so many carriers of enteric organisms, and food infections are transmitted by food-handlers with poor hygienic habits living in inadequate environmental sanitation conditions, it will be only occasionally possible to confirm that food products coming from the area reusing effluents was the cause of infection. To confirm this beyond doubt, it would be necessary to obtain the sample of the incriminated
foodstuff (if any would be available) and to isolate from it the respective pathogens. Only rarely are all favourable circumstances met so that the isolations of specific pathogens can be made.

Although from a scientific research point of view this alternative is very attractive, from a cost-effectiveness point of view it is rather discouraging. However after a close look in the possibility to define the study and control groups properly, it became evident that while small groups of agricultural and sewage workers could be identified, there was no certainty that the large consumer populations could be ever possible to identify by any certainty. Thus the number of population under observation would be so limited that their follow up would hardly ever produce such number of enteric fever cases which would permit the comparisons among groups to be made on statistically significant differences. This evidently made the second and the third alternatives highly uncertain as far as the success of the research is concerned.

The last but not least approach considered as promising (in view of the above mentioned limitations) was one to be based on child health and growth. This approach would require reconsideration of some common concepts on epidemiological investigations. If one considers that what really matters is whether one dies of the disease or is incapacitated or his health otherwise suffers because of the disease, then, besides mortality, the general health status reflected in the growth rate of children under one
year of age should be a very relevant indicator of ill effect of diarrhoeal diseases (or their absence) caused by the usage of effluents. This type of study would require at least measurement of the body weight and height of children. Mortality data on children should at the same time be collected. These are relatively easy to collect where reliable death certificates are established using the international standard death certificate and related procedures. However, as the study population of San Juan is very small the mortality data would be of little value. Weight and height data would of course be of greater value. These data and some other simple indices of nutritional status are also easily and simply collected and processed.

Since enteric, diarrhoeal diseases are the main cause of poor growth of children due to the vicious circle: diarrhoeal disease - malnutrition - diarrhoeal disease; the ill effects of these diseases would be reflected on children's growth curves. Therefore precise measurement of children's (0-1 and possible 0-5 years) weight and height every 2-3 months could show health impairments (if any) and/or benefits of the use of effluents for food production.

** ***

13 Ninth (1975) Revision of the International Classification of Diseases
It goes without saying that several other ways to formulate the research proposal were considered. A suitable combination of the various alternatives listed would depend on (a) selected high risk population group(s); (b) selected diseases of great severity, easy detection and diagnosis, and of high socio-economic importance (e.g. typhoid, or diarrhoeal disease in children who are a specially vulnerable age group).

Although the food consumers group was considered impossible to include because of the difficulties to identify consumers, it was observed that for a few products (e.g. milk), there are some individuals who, due to closeness of the places where they lived and/or because of close, friendly relations with the producer, they used regularly the food produce by that particular farmer. It is possible that at San Juan and neighbouring places with a rapid population growth more local people could be identified in the future as regular users of specific food products from individual producers so that the risks of food contamination by the effluent could be assessed by tracing the path of infection. This identification would require the results of the preliminary socio-economic survey which was mentioned earlier.

3.2 Epidemiological evaluation which could be widely applied all over Peru

It was considered that such an evaluation should be conceived in the light of existing manpower and equipment facilities in the country. This calls for methods that are technically and financially feasible, yet reliable, inexpensive, simple to carry out and easy to interpret.
3.2.1 The first approach mentioned above (bacterial, parasitic and viral testing of effluent safety) could be adopted if central virus laboratory services in Lima would be strengthened.

3.2.2 The second approach based on infant mortality and specific (enteric and diarrhoeal) diseases mortality could be combined with the last one: assessment of the children's (0-5 years) growth rates based on the measurement of height, weight and possibly other indices related to their nutritional status.

3.2.3 The above two (3.2.1 and 3.2.3) approaches could be entirely or selectively combined. This seems to deserve particular attention, because although this approach might be less attractive from the epidemiological research point of view it might prove feasible and rather revealing as far as health effects of the reuse of effluents is concerned.

***

It is difficult to make a sound decision on the appropriate type of the study to be proposed when basic data on which such a decision should be made are not available (e.g. enteric diseases incidence, prevalent modes of their spread; reliability of death certificates and of diseases notification). Therefore, a preliminary pilot study to provide such data might be needed in order to rationally select the most appropriate approach to the study.
4. THE PROPOSED STUDY

The type of the study was determined and its protocol formulated after decisions had been made on the approaches to be applied (see annexed protocol of the study). The problems mentioned in view of the alternatives to the type of study, indices to be used and various constraints such as the impossibility to identify a consumer study group and to find a comparable control community were considered. There appears to be in addition a few other general aspects which deserve consideration.

4.1 Expectations of epidemiological studies

Assuming that, after a search it is concluded that the reuse of effluents does not cause any cases of infectious disease(s) in the exposed community, the epidemiological study would then only prove what is already expected from the results of the study on bacterial, parasitic (and viral) contaminations of the effluents.

Assuming that in an epidemiological study, a significant difference is found in the incidence of enteric infections among those who are exposed and those not exposed to treated or untreated effluents, this will not prove that the quality of effluents is the cause of the difference, because in populations like those in Lima there are many sources of infection (the carriers and the sick), and many ways for it to spread. Unless incriminated food suspected to be contaminated is microbiologically confirmed to carry pathogens, no definitive conclusion can be made from whatever intensive and extensive epidemiological investigations as might have been undertaken.
Since any such epidemiological (longitudinal) study requires sustained support, it might happen that sponsors could soon be disappointed (in view of their unrealistic expectations) because of a lack of rapid and clear cut results, and therefore might refrain from further supporting the study.

4.2 Interpretation of findings

Microbiologically poor quality of effluent can be interpreted as presenting certain health risks. If such risk would be present, this however would not in any way imply that the food produced is actually contaminated as microorganisms may not come in direct contact with food or they may die out between the time of use of effluent for irrigation and the time of consumption of the food. On the other hand, perfectly safe food in view of its contamination by effluent might be however contaminated otherwise e.g. by illicit use of raw sewage, by defecation of agricultural workers in the field, contamination of food by food handlers (carriers with poor personal hygiene and without environmental sanitation facilities). So even if the incriminated food is found and proved contaminated there is no evidence that that food contamination was due to effluents reuse.

Then someone may ask why all these sophisticated epidemiological enquiries were made when definite conclusions cannot be drawn?

4.3 Behavioural versus epidemiological investigations and interventions

If the safety of effluents can be assessed as appears to be possible by laboratory tests, then the other sources of infection should also be looked for as they may prove to be of primary importance. Epidemiological investigations to this effect should comprise testing of individuals handling
food and others for their possible carrier state. This would require continuous and elaborate follow-up supported with laboratory investigations. But, even if a carrier is found this does not mean that he has necessarily contaminated the food; yet he could have done it provided that his behaviour was conducive to food contamination. This raises the question, should observations of behavioural patterns be included in epidemiological investigations? If e.g. it is found that a certain proportion of the agricultural workers defecates in the field, it could be easily estimated (as about 2-3% of them in Lima are carriers of S. typhi\textsuperscript{14}) what the probability is that such practices on the part of carriers will lead to fecal contamination of vegetables. Hand washing and the defecation habits of food handlers give another element for assessing the risks. Moreover, such behavioural investigations, if carried out by a well-trained social scientist, can also provide information on how these habits could be changed and so could lead to infection control by intervening with appropriate public health education.

Thus the question arises whether costly, complex and sophisticated epidemiological enquiries might not better be replaced with corresponding behavioural studies, directly related to the control of food-borne diseases?

If the above argument is accepted, then there is a need for a reevaluation of the alternatives given above and for switching in this study from the classical epidemiological point of view based on the concept of infectious diseases, to the behavioural areas. Of course, there is no reason

\textsuperscript{13} Ovjetanovic\textsuperscript{b} and G. Grab; Epidemiological model of typhoid fever with age. Unpublished document of CDD/WHO, Geneva; (1983). (Presently on loan to Dr. R. Black, Instituto de Investigación Nutricional, Lima)
why these two disciplines should not be combined and their relative advantages used to make the epidemiological and socio-economic evaluation a single, rationally combined, interdisciplinary undertaking. This combination of strategies has been adopted in the protocol. Interdisciplinary cooperation offers some additional advantages in that it provides more information relevant for appropriate control for less expenditures.

***

The proposed study design and the protocol (see Annex) were prepared with the above considerations in mind. They represent a compromise between ideal study and feasible reality. This presentation in fact represents the justification and rationale for the approaches adopted for the study proposed.

The concept of the study design is presented synoptically in the self-explanatory flow chart (Table 1) of socio-economic processes and the evolution of health which will be observed in the study population. Specific health and socio-economic factors and indices to be measured in order to describe and quantify the process, the related health risks, and the health and socio-economic benefits are also presented.

4.5 Some possible delimmas

An important difficulty in the study may derive from not being able to identify and segregate the people exposed to a given grade of treated effluent (secondary, tertiary, quaternary, untreated), from the cultivated products they consume. The people consistently trade among themselves food produced by all types of effluents, so those growing produce with raw sewage are exchanging food with those using treated waters of varying qualities for irrigation.
These exchanges are complete among cultivators and between them and the outside populations. Additionally, field laborers are hired and frequently bring in their children.

It was observed that raw, untreated sewage also flows through the community in an open gutter and a substantial number of individuals, particularly children, come into contact with it. Moreover, animals in contact with the effluents are everywhere. Seagulls, cattle, egrets and wild ducks roost in the untreated effluent receiving pond of the upper battery, as well as in most of the other ponds. The people practice open air excretion, children near the patio and adults out in the fields. Barnyard fowl run freely about the yard and in the fields, consuming excreta as they forage and depositing their own. Aerosolization of contaminants in this desert climate, and their propagation and deposit by the continuous breezes may be another aspect to consider. Consistently dependable operation of the ponds may not be possible to guarantee, as it was observed that secondary effluent was being discharged when it should have been retained for tertiary treatment.

In effect, some sectors of the population may be using effluents which have been passed through two, three or four stages of treatment, while others are using untreated effluents; it may not be possible to discriminate among them because of this "mixing" of contaminants. The population may be homogeneous with respect to its contact with contaminants from all sources. Hence, a zoning of the cultivation areas according to the quality of the treated effluent being used, and a classification of products derived from the respective effluents, may be impossible to achieve.
To summarize, there are at least three possible delimiters which may affect the realization of the study: 1) the inability to guarantee the quality of the treated wastewater at the site of its use; 2) the inability, assuming the wastewater is monitored for its quality, to prevent contamination from numerous sources, of the produce in the field during cultivation leading to harvest; and 3) the inability to prevent contamination from numerous sources after harvest, at the moment of entering into distribution (tested F.O.B. before leaving the farmyard).

4.6 Components of the study

Although the study is conceived as a single, multidisciplinary investigation of health and socio-economic aspects of effluent reuse, it might be useful to look at its components separately. This might allow in case of budgetary constraints to give priority to some components of the study and carry these out while putting the others aside. For this reason the components of the study are presented in self-explanatory Table 2.

(1) Health risks studies can be carried out separately; they can embrace both effluents and food, or only one of these two components.

(2) Health effects can be added to the above or carried separately either one or both based on strictly nutritional and anthropometric investigation by the Nutrition Research Institute. Diarrhoeal diseases and enteric infection studies can be combined with the nutritional one or undertaken separately. It goes without saying that if combined, the cost-effectiveness is increased. For example, these last components can be financed by the Diarrhoeal Diseases Control Programme of PAHO.

(3) Behavioral practices, socio-cultural characteristics and economic aspects can also be done separately.
The separation of the study into various components (subdivided as on Table 2 or possibly in other ways) might be useful when considering the budgeting of the proposed study.

5. PERSPECTIVES FOR FUTURE STUDIES

In spite of the constraints which lead to the modification of some of the initial concepts of the study, the advantage of the present, longitudinal analysis of the microbial and toxic contaminants in the effluents, and presents an characterization of the population which can serve as a baseline for future studies. These could be directed:

(a) towards evaluation and follow-up of other health interventions in addition to alterations to improve the effluent treatment operation, such as:
   - health education of the population on personal hygiene and health care;
   - construction, maintenance and proper use of sanitary facilities (toilets, wash basins, drinking water cisterns, etc.);
   - modifications of the built environment for improved sanitation;
   - proper handling and transport of food products;
   - etc.

(b) towards the development of additional socio-economic activities aimed at maximizing the health, social and economic benefits by:
   - improvement of food production quality and quantity;
   - education in food selection and preparation for improved nutrition;
- food preservation and/or processing, at home and for marketing;
- introduction to new production methods by better use of effluents, land, crop selection;
- introduction of appropriate technologies for improved health and economy.

Actually, the proposed study could be considered primarily as aimed at establishing an epidemiological and socio-economic baseline for future studies on the development of effluent reuse systems. Although the study is primarily descriptive by nature, as a case study it will provide indices and a model for comparison with other populations both national and international.
Table 2. **Components of the proposed epidemiological and socioeconomic study in San Juan de Miraflores effluent reuse project**

<table>
<thead>
<tr>
<th>Subject of the study</th>
<th>Investigation technology</th>
<th>Investigating Institutions**</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Health risks of:</td>
<td>Parasitology</td>
<td>CEPIS</td>
<td></td>
</tr>
<tr>
<td>- effluents</td>
<td>Bacteriology</td>
<td>INS/LB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Virology</td>
<td>INS/LV.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toxicology</td>
<td>CEPIS/Tox.Lab***</td>
<td></td>
</tr>
<tr>
<td>- food products</td>
<td>Parasitology</td>
<td>CEPIS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bacteriology</td>
<td>INN</td>
<td></td>
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<tr>
<td></td>
<td>Virology</td>
<td>INS/LB</td>
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<td></td>
<td>INS/LV</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Toxicology</td>
<td>CEPIS/Tox.Lab***</td>
<td></td>
</tr>
<tr>
<td>2. Health effects of:</td>
<td>Anthropometry</td>
<td>IIN</td>
<td></td>
</tr>
<tr>
<td>- effluent reuse</td>
<td>Nutritional status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- food products</td>
<td>Diarrhoeal Diseases</td>
<td>IIN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enteric infections</td>
<td>INS/LB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surveillance</td>
<td>INS/LV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serologic survey*</td>
<td>UPCH</td>
<td></td>
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<td>3. Socio-economic and</td>
<td>Observations and</td>
<td>CEPIS</td>
<td></td>
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<tr>
<td>behavioural factors</td>
<td>Interviews on</td>
<td>IEP</td>
<td></td>
</tr>
<tr>
<td>related to health</td>
<td>Behavioural practices</td>
<td>ECO</td>
<td></td>
</tr>
<tr>
<td>effects: Risks &amp;</td>
<td>Sociocultural character.</td>
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<td></td>
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<tr>
<td>Benefits</td>
<td>Economic status &amp;</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>consumption levels</td>
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<td></td>
</tr>
<tr>
<td>TOTAL:</td>
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<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

* Typhoid and paratyphoid, hepatitis A (leptospirosis)
** An external collaborating laboratory

CEPIS - Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente
INS - Instituto Nacional de Salud
INS/LB - Bacteriological Reference Laboratory
INS/LV - Virological Reference Laboratory
IIN - Instituto de Investigación Nutricional
UPCH - Universidad Peruana Cayetano Heredia
IEP - Instituto de Estudios Peruanos
ECO - Centro Panamericano de Ecología Humana y Salud
6. SUMMARY AND CONCLUSIONS

The importance of the reuse of effluents for the health and wellbeing of the populations of Peru is evident and studies aimed at its safe and effective use are indicated.

To assess the health risks and benefits of the use of treated (and untreated) effluents for food production in agriculture and pisciculture, epidemiological observation of the large population working with effluents and producing food, and those consuming it would be ideal, provided these populations and the food they consume can be identified, and extensive and thorough epidemiological surveillance can be carried out for at least a year or two. Such an approach, if supported by a necessary laboratory investigation, could meet scientific requirements but would incur relatively high costs.

The actual conditions, with constraints arising from an inability to clearly identify food consumers (and thus leaving only a very small population to be observed) required in the planning process of the study that the emphasis be put on environmental quality assessment of effluents and food products by laboratory methods, in order to assess the risks of parasitic bacterial and viral contamination.

The health risks and especially health benefits, both the direct ones from the consumption by farmers of the food produced, and the indirect, socio-economic ones derived from effluent reuse, will be based on investigations of health and nutritional status, growth rates and diarrhoeal diseases in children, basic need satisfaction, consumption patterns, the production of surpluses and their uses, household budgets, and attitudes about wellbeing, quality of life, and future outlook. The study is conceived as a descriptive, longitudinal case study.
The importance of adopting interdisciplinary, integrated study methods emphasizing the synthesis of various observations leading to unified results cannot be overemphasized if the study is to produce conclusions and recommendations which will be effective in furthering the development of similar projects for treated effluent reuse in Peru.

6. TABLES:

Table 1. Chart of Dynamic Flow of effluent reuse economic processes and related health risks and benefits, and the epidemiological and socio-economic study of these dynamic processes.

Table 2. Components of the proposed epidemiological and socio-economic study in San Juan de Miraflores effluent reuse project.

A Protocol for

EPIDEMIOLOGICAL AND SOCIOECONOMIC INVESTIGATIONS OF HEALTH IMPACTS

FROM THE USE OF TREATED EFFlUENTS FOR IRRIGATION

IN

SAN JUAN DE MIRAFLORES

CENTRO PANAMERICANO DE INGENIERIA SANITARIA Y CIENCIAS DEL AMBIENTE (CEPIS)

Lima, Peru

January 1984
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   2.3 Socio-Economic Investigations
   2.4 Dissemination and Application

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   II. Microbiological Methods
   III. Toxicological Methods
   IV. Health, Nutrition and Diseases
   V. Behavioural Practices, Socio-cultural Characteristics and Economic Activities
1. INTRODUCTION

The San Juan de Miraflores effluent reuse project is aimed at providing safe effluent for agriculture and aquaculture. The project began in 1961 with the construction of experimental waste stabilization ponds for the treatment of effluents. CEPIS has undertaken extensive field and laboratory studies of the quality of the effluents. Some operations have been completed while others are under way and additional investigations are in order to complete the analysis of effluent reuse, as shown on the self-explanatory chart (Figure 1).

The field and laboratory studies carried by CEPIS and collaborating institutions on the quality of the effluent in sewage stabilization ponds in the experimental San Juan Project have been evaluated. These studies demonstrate that an acceptable quality of the effluent has been attained as far as bacterial and parasitic contaminations are concerned. Virological and toxicological investigations are still required to ascertain fully the quality of the effluent from the beginning to the end of the stabilization process, and its suitability for agricultural irrigation and pisciculture.

A full characterization of the microbiological and toxicological quality of the effluent is necessary. There is a need for epidemiological and socio-economic characterizations of the populations directly involved in the project and for the assessment of the health risks and health and socio-economic benefits of the effluent reuse.

When completed, the epidemiological and socio-economic studies of the effects of the San Juan reuse project, together with the earlier analyses, will be used to demonstrate the utility of financing the construction of a similar but larger system to treat effluents from the southern cone of the Lima Metropolitan Area, to achieve a water quality fit for reuse in the irrigation of the Pampas of San Bartolo and surrounding areas. It is estimated that 5,000 ha of desert may be put into cultivation reusing 5-3 m$^3$/s of wastewater treated by this technology$^3$.

Therefore, the epidemiological and socio-economic investigations being proposed here are to be considered in the light of their potential contribution towards a more effective and beneficial reutilization of effluents in the future in Peru, as well as elsewhere in Latin American arid zones. The proposed study will also contribute to the achievement of goals set by the UN International Drinking Water Supply and Sanitation Decade and the targets of the WHO Programme of Health for All by the Year 2000.

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$^3$ SERPAR, "Proyecto de cooperación técnica en el campo de la preinversión referente al reuso de aguas servidas para irrigación de las Pampas de San Bartolo y lugares aledaños (distritos de Lurín y San Bartolo). Lima; Servicio de Parques, 6 de noviembre de 1981."
2. PURPOSE OF THE STUDY

2.1 General:
- to investigate epidemiological and socio-economic factors which affect the safety and efficiency of the reuse of treated effluents for agricultural purposes in the San Juan de Miraflores Project, and
- to assess the health risks and benefits of this project to (a) the operators of the waste stabilization ponds, and (b) the agricultural workers and their families using the effluents.

2.2 Epidemiological Investigations:
- to investigate the presence, the quantity and the dynamics of parasites, bacteria, and viruses selected as indicators of microbial contamination of effluents at various phases of treatment;
- to investigate the presence of toxic substances found in the effluent;
- to evaluate health risks due to the presence of pathogenic organisms and toxic substances in the effluents resulting in the contamination of food products;
- to assess the role of behavioural patterns and health practices of the agricultural workers and their families, and the presence of domestic animals in the contamination of food products in the field before use and/or marketing (in conjunction with the socio-economic investigations).

2.3 Socio-economic Investigations:
- to study the interrelations of social, cultural, economic, educational and behavioural factors of the farm families with respect to effluent reuse and the effects on health, quality of life and well-being;
- to study the factors conducive to the contamination of food products for marketing and for personal consumption such as improper use of effluents, inadequate personal and environmental hygiene practices;

- to investigate the basic social organization of the household, living conditions, work arrangements and division of labor, individual and family behavioural practices, sources and types of food and consumption patterns, household budgets for the allocation of time and resources, the socio-economic infrastructure of cultivation, harvest and commercial distribution of products during the annual cycle, and reinvestment opportunities;

- to coordinate socio-economic studies with the epidemiological investigation in order to establish the mode of interaction of factors which contribute to the benefits as well as the possible risks to health and well-being associated with the reuse of effluents.

2.4 Dissemination and Application

- to use the information obtained from the results of the above study in the formulation of proposals for the improvement of the quality of the treated effluents, the safety of food products, the improvement of environmental sanitation and by extension, the health status and the quality of life of the population.
3. STUDY DESIGN

The study is conceived as an observation and description of the health and socio-economic effects of the reuse of treated effluents for agricultural, fish and animal food production.

The qualitative and quantitative aspects of the dynamic flow of the socio-economic processes related to health, namely the inputs (waste stabilization ponds, their maintenance, effluent use, etc.) and the outputs (vegetables, fruit, fish, eggs, milk, fodder production, etc.) as well as the health (nutritional status, diseases) and economic benefits (food products for use of market income) derived from the effluent reuse will also be expressed in health and disease indices, socio-economic indicators and in economic terms wherever feasible.

The duration of the study is planned for an initial period of two years including a one-year period of essential observations, a half-year for preparation, and another half-year for analysis of the results, and the preparation of the report. An optional second year of observations after the intermediary evaluation of the study during latter part of the first year of observation, may be proposed if deemed necessary.

3.1 Population and Area

3.1.1 The population which will be studied comprises the employees of the effluent treatment plant, and the agricultural workers and their families farming the lands irrigated by the effluents and using the produce.
The composition of the population of 124 individuals to be studied completely (estimated from field visits) is given in the Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Number of Households</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment Workers</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Agricultural Workers</td>
<td>32</td>
<td>12</td>
<td>13 69 51</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>54</td>
<td>33 27</td>
</tr>
</tbody>
</table>

A population census will be made by household visits shortly before the beginning of the study and all relevant basic demographic characteristics will be collected. The changes and the dynamics of the population will be followed and household and individual cards kept up-to-date. The general methods for the population census, employing a household roster, household and individual record cards are described in the Annex I. More detailed census information required by the individual study sectors will be indexed to these basic tracts.
Specific control groups of populations meaningfully comparable in all aspects to the study population were not possible to identify and therefore control groups are not included in the study.

A comparison of observations and findings in the study population will however be attempted with other population groups in Lima having similar epidemiological and socio-economic characteristics. This comparison will serve as a rough evaluation and will not provide a basis for establishing the statistical significance of the observed differences.

3.1.2 The area of influence of the San Juan de Miraflores effluent reuse project, the location of stabilization ponds and the lands settled and cultivated by the households are shown in Figure 2.

3.2. Indices and Parameters

3.2.1 The epidemiological indices and parameters listed below will be used to determine (a) health risks related to contamination by the agents of infectious diseases and toxic substances in effluents and food products, (b) the level of health, and (c) the health benefits.
3.2.1.1 Quality of Effluents and Food Products

A. Microbiological contamination*

1. Protozoa and helminths

2. Bacteria (E. coli, E. coli-fecalis, Salmonella and Campylobacter)

3. Viruses (Hepatitis A and enteroviruses).
   (Samples taken every two months for effluents at four
   points and samples of food at harvesting time).

B. Toxic Substances**

1. Organic compounds

2. Inorganic compounds
   (Samples taken as under A above).

3.2.1.2 Health Nutritional and Diseases***

A. Health

1. Health of population: morbidity (recording through the
   year)

2. Access to and use of medical consultations

* Methods for the assessment of microbiological quality of (a) effluent
  and (b) food products (see Annex II).

** Methods for the assessment of toxic substances in (a) effluent and (b)
  plants and food products (see Annex III).

*** Methods for the assessments of nutritional status, the incidence of
  diarrhoeal and enteric diseases (see Annex IV)
B. Nutrition

3. Anthropometric indices (at varied times according to age)
4. Growth rates for children under one year of age
5. Nutritional status, diet survey (in conjunction with the socio-economic study)

C. Diseases

6. Diarrhoeal diseases and enteric infections incidence by etiology in children under five years of age (by continuous surveillance)
7. Infestation of population with intestinal parasites (annual survey)
8. Carriage of S. typhi and S. paratyphi B (annual survey)
9. Serological evidence of infection with hepatitis A and leptospiroses (annual survey)

3.2.2 The socio-economic investigation has been subdivided into three components to facilitate data gathering and analysis: A. the behavioral practices of the study population which may affect its health status and productivity; B. the socio-cultural characteristics which define the population and the way it operates; and C. its economic activities in the context of the foregoing, placing emphasis on the satisfaction of basic needs, its capacity to sustain an acceptable level of health and well-being, and to contribute productively to national life, society and economy.

Socio-economic indicators* of the wastewater users which may (a) affect their level of health, present risks, or (b) provide benefits to health, economic status, quality of life and well-being are measured by qualitative scaling techniques except where indicated.

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* Methods for gathering data to produce these indices, the frequency of interviewing and other details are presented in Annex V.
A. Behavioral practices

1. Personal cleanliness
2. Hygienic food handling, preparation and consumption
3. Maintenance of environmental sanitation
4. Toilet habits
5. Use of clean water
6. Animal contact
7. Human contact
8. Attention given to illness

B. Socio-cultural characteristics

1. Level of education
2. Information access – literacy, media use
3. Family type
4. Perceptions (attitudes) of health, illness and risks
5. Access to, and use of health services
6. Food preferences, quantity, variety, quality (as measured by 24-hour dietary recall techniques with calculations for intake of calories and balance among essential nutrients, vitamins and minerals)
7. Habitation density (people per m² of living space)
8. Self-perception of health, well-being, quality of life and aspirations.
9. Membership in mutual benefit associations
C. Economic indicators

1. Farm produce income, expenditure and surpluses (gross cost of products sold, traded, consumed, shared or lost plus production expenses including hired help, subtracted from the net value of income from all sources of farm production)

2. Other incomes and their sources

3. Household and personal maintenance expenses, including services and health care (compilation of a detailed household budget)

4. Formal education expenses per individual

5. Somatic energy expenditures in k.cal. per hour by age, sex, division of labor, task responsibilities and seasonal cycles (estimates based on observation of behavior and appropriate charts)

6. Mechanical energy expenditures in k.cal per hour in all day-to-day activities including fuel for motors

7. Habitation status, own, rented, quality of structure (if owned, its monetary valuation), value of property owned elsewhere

8. Expenses for leisure, travel, recreation, acquisition of non-essentials, donations

9. Expenses for the acquisition of information

10. Valuation of the price of equivalent land occupied.
3.3 Methods and Instruments

A. Methods

3.3.1 Methods for the population census, and recording on household and individual record cards are described in Annex I.

3.3.2 Microbiological methods (parasitological, bacteriological and virological) used for assessment of (a) quality of effluent and (b) quality of food products are described in the Annex II.

3.3.3 Toxicological methods for assessment of toxic substances in (a) effluent and (b) plants and food products are given in the Annex III.

3.3.4 Methods for assessment of (a) health and nutritional status, (b) growth rates in children and (c) prevalence of diarrhoeal diseases and enteric infections are given in Annex IV.

3.3.5 Methods for data collection and the assessment of (a) behavioural practices, (b) socio-cultural characteristics and (c) economic status are presented in Annex V.

B Instruments

The annexes describing the methods also give relevant information on the instruments, sampling, surveys, surveillance laboratory testing, field observations, etc.
4. PLAN OF OPERATIONS

4.1 Preparations

The testing of the protocol of the study in the field will take place during the six-month preparatory phase, utilizing methods and instruments described in the annexes by the staff who will be engaged in the investigations. According to the experience gained in the above field testing, the protocol will be modified as necessary before final adoption.

The training of the staff to be involved in the proper application of the protocol will likewise be carried out during the preliminary six months before the beginning of the investigations.

4.2 Census

A census of the population will be carried out according to the methods and forms described in the Annex I. The census will serve to establish a household roster and folders for households and individuals, with cards for recording the results of various investigations related to individuals and families.

4.3 Epidemiological Investigations

The study comprises an assessment of the health impacts (risks and benefits) of the reuse of effluents and related socio-economic aspects. The epidemiological investigations are composed of several distinct components which are summarily presented in the self-explanatory Table 2, which indicates the subject of the study, the type of investigation, study requirements, resources needed and cooperating institutions.

4.3.1 Quality of Effluents and Food Products

The quality of effluents will be monitored every two months, and in a similar way food products will be tested (see Annexes II and III) using (a) microbiological and (b) toxicological testing techniques.
Table 2. COMPONENTS OF THE
(Subjects, Investigations, Requirements, Resources Needed)

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>INVESTIGATIONS</th>
<th>REQUIREMENTS</th>
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</table>
| A. HEALTH RISKS OF EFFlUENTS | PARASITOLOGICAL TESTS  
(a) BACTERIOLOGICAL TESTS  
(b) VIROLOGICAL TESTS  
(b) TOXICOLOGICAL TESTS | SAMPLING PLANNING  
SAMPLE COLLECTION  
SAMPLE EXAMINATION  
SAMPLE EXAMINATION |
| B. HEALTH RISKS OF FOOD PRODUCTS | PARASITOLOGICAL TESTS  
(a) BACTERIOLOGICAL TESTS  
(b) VIROLOGICAL TESTS  
(b) TOXICOLOGICAL TESTS | SAMPLING PLANNING  
SAMPLE COLLECTION  
SAMPLE EXAMINATION  
SAMPLE EXAMINATION |
| C. HEALTH EFFECTS OF EFFlUENTS REUSE | HEALTH  
NUTRITIONAL STATUS  
ANTHROPOMETRY | MORBIDITY RECORDING  
SAMPLING PLANNING  
LABORATORY TESTS  
MEASUREMENTS |
| D. HEALTH EFFECTS OF EFFlUENTS REUSE | DIARRHOEAL DISEASES  
ENTERIC INFECTIONS  
SURVEILLANCE  
SEROLOGICAL SURVEY | FIELD SURVEILLANCE  
SAMPLING  
LABORATORY TESTS |
| E. SOCIO-ECONOMIC & BEHAVIOURAL FACTORS RELATED TO HEALTH EFFECTS: RISKS & BENEFITS | BEHAVIOURAL PRACTICES  
SOCIAL-CULTURAL CHARAC- 
TERISTICS  
ECONOMIC ACTIVITIES AND CONSUMPTION LEVELS | FIELD VISITS, OBSERVATION:  
OPEN AND CLOSED-ENDED INT:  
CHECKLISTS, PERIODIC RESI  
IN COMMUNITY, CALCULATION  
HOUSEHOLD BUDGETS, ENERGY  
SURPLUSES AND THEIR USES |
| F. EVALUATION, ASSESSMENT OF RESULTS & REPORTING | ALL ABOVE | DATA ANALYSES  
INTERPRETATION OF RESULTS REPORTING |

IS = Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente  
/LB = Instituto Nacional de Salud, Laboratorio de Bacteriología  
/LV = Instituto Nacional de Salud, Laboratorio de Virología  
  = Instituto de Investigación Nutricional  
H = Universidad Peruana Cayetano Heredia
RESOURCES NEEDED | Cooperating Institutions
---|---
EQUIPMENT & REAGENTS | CEPIS
MANPOWER (MICROBIOLOGIST, VIROLOGIST) TOXICOLOGIST | INS/LB
TRANSPORT | INS/LV

EQUIPMENT & REAGENTS | CEPIS, IIN
MANPOWER (MICROBIOLOGIST, VIROLOGIST, TOXICOLOGIST) | INS/LB
TRANSPORT | INS/LV

EQUIPMENT, REAGENTS | IIN
MANPOWER (NUTRITIONIST) | INS/LB
TRANSPORT | INS/LV

EQUIPMENT | IIN
REAGENTS | INS/LB
MANPOWER (EPIDEMIOLOGIST) & TRANSPORT | INS/LV

FULL TIME FIELD WORKERS, SOCIAL-ANTHROPOLOGIST FOR ENERGY BUDGET/INPUT OUTPUT METHODOLOGY & ANALYSIS | CEPIS
TRANSPORT | ECO

SHORT-TERM CONSULTANTS: SOCIAL-ANTHROPOLOGIST EPIDEMIOLOGIST | CEPIS
| ECO
EXTERNAL ADVISORS

P = Instituto de Estudios Peruanos
O = Centro Panamericano de Ecología Humana y Salud

Toxicological External Laboratory to be contacted for analyses
4.3.2 Health, Nutrition, Diarrhoeal Diseases and Enteric Infections

The health and nutritional status of the study population will be assessed according to the methods given in Annex IV. The nutritional status of the children will be monitored every three months or otherwise as specified in the above Annex, and consumption patterns will be determined in conjunction with socio-economic observations. Continuous surveillance on weekly basis will be made for diarrhoeal diseases and enteric infections by surveys and surveillance. Serological and microbiological surveys will be carried out for selected infections.

4.4 Socio-economic Investigations

The behavioural practices, socio-cultural characteristics and economic activities components of this study will be investigated according to the methods and instruments described in the Annex V.

4.5 Evaluation

Evaluation of the study and of its results will be made periodically during the course of the 12-month period of data gathering. A final evaluation will determine whether the study is complete or whether there is a need to extend it.

Evaluation of the results obtained as to their reliability, will be made at the end of investigations.

4.6 Chronogram

The timing and the sequence of the operations related to the study are shown on the chronogram (Table 3). In this chronogram the one year and two years periods of observations are presented as alternatives; the first year being essential and second optional.
<table>
<thead>
<tr>
<th>STUDY PHASES</th>
<th>A. PREPARATORY: 6 Months</th>
<th>B. OBSERVATIONS: FIRST YEAR: 12 months</th>
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<td>MONTHS</td>
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<td>A. Preparatory</td>
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<td>4) Census (a) baseline data (b) follow-up</td>
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<td>B. Observations</td>
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<tr>
<td>5) Nutritional &amp; health status (a) baseline data (b) follow-up (every 3 months)</td>
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<td>6) Body height &amp; weight (every 3 months)</td>
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<td>7) Diarrhoeal diseases surveillance</td>
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<td>8) Socio-economic and behavioural observations</td>
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<td>9) Water quality testing (every month)</td>
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<td>C. Evaluation &amp; Analysis</td>
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<td>10) Analysis &amp; interpretation of results</td>
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<td>11) Evaluation (a) intermediary (b) final</td>
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<td>12) Preparation of the report (a) annual (b) final</td>
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B. OBSERVATIONS (optional)
SECOND YEAR: 12 months

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EVALUATION AND ANALYSIS
6 months

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4.7 Collaborating Institutions

4.7.1 CEPIS will carry out the operational, engineering, and water quality (microbiological and toxicological aspects) of the study.

4.7.2 The Instituto de Investigación Nutricional (IIN) will undertake studies on health and nutritional status and diarrhoeal and enteric diseases, and food quality.

4.6.3 The National Institute of Health Bacteriological Laboratory (INS/LB) will assist as Reference Laboratory in microbiological and parasitological examinations, and its virological laboratory (INS/LV) in virological examinations.

4.7.4 The Peruvian Medical School "Cayetano Heredia" (UPCR) will assist epidemiological inquiries related to enteric infections.

4.7.5 The Pan American Center for Human Ecology and Health (ECO) will cooperate by performing the socio-economic study in collaboration with the Instituto de Estudios Peruanos (IEP).

4.8 Principal Investigator, Associate Principal Investigator, and Co-investigators

4.8.1 The Principal Investigator's responsibility is to provide a centralized support function which will coordinate the work of co-investigators from various institutions in this joint, interdisciplinary study, to facilitate the exchange of information among co-workers, and to assist them in the efforts to make a sound synthesis of the observations and of the results obtained.

4.8.2 The Associate Principal Investigator's responsibility is to work conjointly with the Principal Investigator and the co-investigators in the coordination and integration of the design and execution of the
study; particularly in the tasks of transforming the study protocol into operational procedures, techniques and time-tables; training of the study participants in specific aspects of its multi-disciplinary components; performing periodic evaluations of the course, progress and complementarity of investigative procedures during the data gathering phase of the study; presentation of the results of the study.

4.8.3 Co-investigators from cooperating institutions will be responsible for the specific tasks assigned to them, according to this protocol (see: (a) above; 4.7; (b) 7, and Annexes: II, III, IV and V).

4.8.4 The responsibility for the execution of the study will be entrusted to the principal investigator, associate principal investigator, and co-investigators listed as follows:

Principal investigator: Dr. Carl R. Bartone (CEPIS) and

Associate Principal Investigator: Dr. Thomas S. Schorr, Anthropologist (ECO)

Co-investigators:

Dr. Miguel Campos, Epidemiologist (UPCH)

Dr. Arturo Gaetañaduy, Food Microbiologist (IIN)

Dr. Oscar Grados, Bacteriologist (INS/BV)

Dr. José Matos Mar, Anthropologist (IEP)

Dr. Carmen de Mayo, Microbiologist (CEPIS)

Ms. Rosario Méndez, Virologist (INS/LV)

4.9 Data Analysis, Interpretation and Use of the Results

4.9.1 Data Analysis

...and contributing to the integrated analysis of data and the final
4.9.1.1 The analysis of data from the monitoring of the quality of (a) effluents, and (b) food products (3.2.1.1) to be performed by CEPIS and collaborating institutions, will provide the basic information needed for evaluation of the health risks.

4.9.1.2(a) The analysis of data from the health and nutritional status (3.2.1.2) investigations, carried out by Instituto de Investigación Nutricional, will be made in order to evaluate the health level of the populations; especially, the health of young children will be assessed and analyzed in the light of the nutritional status and growth curves of children.

(b) The analysis of data on the incidence of diarrhoeal diseases and enteric infections (3.2.1.2) will be made from records on surveillance, surveys and laboratory findings.

4.9.1.3 Analysis of the data from the behavioural, socio-cultural, and economic investigations (3.2.2) will be made by the Instituto de Estudios Peruanos and the Pan-American Center for Human Ecology and Health consulting social scientist(s) in order to determine the socio-economic mechanisms by which the reuse of effluents contributes to general economic status, the satisfaction of basic needs, quality of life, well-being and health of the farm households.

4.9.2 Interpretation of the results

4.9.2.1 The results will be interpreted in the context of San Juan project and the prevailing agricultural, health and socio-economic conditions in Lima in order to determine the health risks and health and economic benefits of effluent reuse, given the circumstances of Peruvian coastal ecology and the prevailing socio-economic situation.
4.9.2.2 The results obtained in San Juan project population will be compared with those obtained in similar populations studied (if possible) by the same study methods and by the same institutions. The comparison of the results obtained in various communities will serve, with due caution as to its validity, as an indicator for assessing health benefits derived from effluent reuse in the San Juan project.

4.9.3 Use of results

The above analysis and interpretation of the results obtained in this study will serve for an overall assessment of the mechanisms leading to health and socio-economic benefits through effluent reuse projects. The results of the investigations will provide information needed for determining the instruments and methods for achieving the improvement of the socio-economic status of the population and for increasing socio-economic and health benefits from effluent reuse. The above information may be employed as a guide for decision making on the specific actions for expanding and increasing the use of the effluents treated by the technology developed and assessed here, and may thus open up new areas of desert to irrigated cultivation. Particularly, the results will serve as a feasibility study for the Pampas de San Bartolo effluent reuse scheme to irrigate and settle 5000 ha of desert land, and will provide design parameters for that project.
4.10  Preparation of the Final Report

The final report will be prepared after the above data analysis has been made and the results and their interpretation reviewed jointly by the investigators, the body of consultants and special advisors. Upon this review, the report will be finished and submitted to CEPIS.

Clearance of the report for publication will be processed by CEPIS.

5.  BUDGETARY REQUIREMENTS

The budgetary requirements and the resources needed in order to execute this study can be estimated from the proposed investigations which are summarily presented on Table 2.
6. SUMMARY

Field and laboratory studies have demonstrated that the treated effluents from the San Juan stabilization ponds are of acceptable quality with respect to bacterial and parasitic contamination so as to allow for the reuse of this water in agriculture and aquaculture. The microbiological and toxicological studies of effluent and food products and epidemiological and socio-economic investigations of the people using the effluents are now needed to complement and extend the analysis of the health risks, and the direct and indirect health and socio-economic benefits of the exposed population.

The investigations are conceived of as primarily observational and descriptive, with quantitative assessments of health risks, and health and economic benefits of treated effluent reuse made whenever possible. The proposed investigations of the dynamic processes of treated effluent reuse are subdivided according to the type of investigation to the specific components. However, the entire investigation is conceived of as interdisciplinary, involving the participation of at least six Peruvian and PAHO institutions. The primary population to be studied is small, about 48 families (125 individuals), enabling complete coverage. It is projected to require six months to organize and coordinate the data gathering procedures, one year to obtain from the population all of the information required, and another six months to complete the analysis and present the results.

It is expected that the final analysis of these combined investigations will lead to the further perfection and installation of this effluent reuse technology for other projects for wastewater reuse in irrigation, putting
hitherto useless land into cultivation for the benefit of the Peruvian
people. At present, the Pampas of San Bartolo to the south of Lima is being
considered as a likely zone for irrigation using the effluents from the
southern cone of Lima. The studies resulting from this proposal will
significantly contribute to the realization and success of the San Bartolo
project, as well as to similar undertakings in other arid lands of the world.

7. ANNEXES:

I  Population Census: Household roster, Household record card, Individual
    record card

II Methods for Assessment of the Microbiological Quality of
    (a) Effluents and (b) Food Products: parasitological, bacteriological
    and virological techniques

III Methods for Assessment of Toxic Substances in
    (a) Effluents and (b) Plants and Food Products

IV Methods for Assessment of Health Nutritional Status, Growth Rates of
    Children Incidence of Diarrhoeal Diseases and Enteric Infections

V Methods for Evaluation of Behavioural Practices, Sociocultural
    Activity Characteristics and Economic Status
ANNEXES

I  Population CENSUS:  Household roster, Household record card, Individual record card

II  Methods for Assessment of the Microbiological Quality of
    (a) Effluents and (b) Food Products:  parasitological, bacteriological and virological techniques

III Methods for Assessment of Toxic Substances in
    (a) Effluents and (b) Plants and Food Products

IV  Methods for Assessment of Nutritional Status, Growth Rates of Children, Incidence of Diarrhoeal Diseases and Enteric Infections

Annex I

CENSUS: HOUSEHOLD ROSTER, HOUSEHOLD AND INDIVIDUAL RECORD CARDS

1. Census of the population is made by preparing (a) roster of the households and filling in (b) household record cards and (c) individual record cards.

2. Household record card serves for basic census of the households members of the family (listed first), relatives (next), and others who are not members of the family (last) are recorded. Any changes caused by birth (do add newborn to the list) or death (add the cause if known) or departure are recorded. This card serves for linkage with all household investigation cards/questionnaires (see Annexes IV & V) and is kept up to date.

3. Individual record card serves for basic information on the individual and for linkage with all other individual investigation questionnaires/cards (see Annexes IV and V). Individuals are identified by four digits serial number which is composed of household roster number (two first digits) and the number of the individual (next two digits) on household card (e.g. 0109 or 1611). Any changes should be recorded and the card kept up to date. These code numbers shall be need on all record cards/questionnaires employed throughout the study.

4. Household folder clearly indicated by number of household and the name of household head on the front page of the folder should contain all other records related to that household which are generated in the course of the study.

5. Individual folder clearly indicated by number of individual and the household and the name of the person should contain all other individual record cards/questionnaires related to that individual which are generated in the course of the study.

6. Annexed:

a. household roster form
b. household record card
c. individual record card
<table>
<thead>
<tr>
<th>Number</th>
<th>Family name(s)</th>
<th>Name(s)</th>
<th>Sex</th>
<th>Year of birth</th>
<th>Number of members of household</th>
<th>Address (predio number)</th>
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Individual record card

Serial Number

Household number (in roster) Address

Individual number (in household card)

Head of the household Apellido paterno
Apellido materno
Nombre(s)

Year of birth: Sex: M F

Individuals name(s) and family name(s) if different from that of the head of the family

[Dates and months]

Record on cards (questionnaires) linkage:

Card number Card established: when by whom Card related to investigation: Date: Observations:

Changes: of place of living, marital status, deaths (cause), etc.
San Juan de Miraflores CEMIS Effluent Reuse Project
Household record card

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* Include the head of household and list him first, his spouse next, then (a) children, (b) relatives, (c) others

** Others than members of family. State relationship in household: servant, etc.
Epidemiological and Socioeconomic Investigations of Health Impacts from the Use of Treated Effluents for Irrigation in San Juan de Miraflores

Annex V

Methods for the Evaluation of Behavioral Practices, Sociocultural Characteristics and Economic Activities

Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente
Lima, Peru
January, 1984
Background

The settlement of farmers using the San Juan effluents for horticultural irrigation is small, limited by the water available to them. Of the estimated total of 32 households (approx. 225 inhabitants), fourteen are situated and cultivate fields in the area bounded by the ponds, the highway and the recreational park. This is the oldest area of occupancy, having been established by the first squatter to enter the zone in June, 1963. Four more families cultivate the strip of land along the highway to the west of the lagoons, and another grouping of fourteen, more recently settled households are situated to the south of the recreational park (see: Fig. 1, p. 8 of the protocol).

These factors of residential proximity to one another, their precarious, illegal status as squatters, a mutual dependency on the pond effluents to sustain their existence, and their dedication to the same productive activities in farming have provided the stimulus leading the households to form a loosely organized agricultural association made up of the heads of the households, aimed at protecting and improving their livelihood, the use of available resources for mutual benefit and the settlement of local disputes.

Besides the three zones of settlement -- between the ponds and the park, on the other side of the highway and below the park -- the cultivated lands may be further zoned by the quality of the treated water which is available for irrigating the household plots. Those situated between the ponds and the park receive effluents which have been released from second, third, fourth and fifth stages of treatment each in succession implying increasing degrees of water quality, while secondary effluents reach the other side of the highway.

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1 Personal communication: Mrs. Maura Rodríguez de Peñiz ("la señora Candelaria") (Jan., 1984).
and the plots below the park use untreated, raw sewage. These coincident relationships among: a) the quality of effluents being used, b) to consistently irrigate specific plots being cultivated by, c) the respective households, will be a principal focus of the combined epidemiological/socioeconomic investigation. Specific attention will be given during the entire course of the investigation to the conditions of environmental sanitation in all aspects of farm life and productivity, especially with respect to the use of effluents for irrigation and the sources of foodstuff contamination. In addition, the eight male employees who operate and maintain the ponds will be interviewed and observed so as to establish their behavioural practices with relation to effluent contact, and any interactions which they may have with the farm households that may involve water use or economic transactions. At present, the design of the study does not include an analysis of the costs related to the functioning and maintenance of the ponds, nor does there appear to be any reliable way to identify a population of exclusive consumers of San Juan products, outside of the farm households. This latter point, however, will be subject to field verification.

As far as is known, there are no socioeconomic studies of the households using the treated effluents of the San Juan stabilization ponds, although much public awareness of their socioeconomic benefits has been stimulated over the years by motion picture and press coverage. On the other hand, a wealth of systematic investigation and analysis has been undertaken over more than three decades by José Matos Mar and his collaborators, on the establishment, socioeconomic organization and evolution of squatter settlements (barriadas, pueblos jóvenes), which is the principal process of

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2 Rúa, Efraín and Manuel Vilca. "La otra cara del relleno sanitario: un montón de belleza". La República, VSD; (1 January 1984, pp. 8-9)
Lima urban expansion. The Matos Mar investigation is continuous\(^5\), producing updated information on the development of the existing barriadas and the new ones which are being regularly established today at an accelerated pace.

Dr. Matos Mar, as Director of the Institute of Peruvian Studies, has produced a preliminary reconnaissance\(^6\) of the social, cultural, economic and demographic characteristics of the settlements in the wider area around the San Juan stabilization ponds, a summary of which is incorporated in this annex.

Methods

As mentioned in the main text of the proposal, the socioeconomic investigation has been subdivided into three components to facilitate data gathering and analysis: a) the \textit{behavioral} practices of the study population which may lead to foodstuff contamination, affect its health status and productivity; b) the \textit{sociocultural} characteristics which define the population; and c) its \textit{economic activities} in the context of the foregoing, and with emphasis on the \textit{satisfaction of basic needs}, its capacity to sustain an acceptable level of health and well-being, and to contribute productively to national life, society and economy.

Pages ten through twelve of the main protocol document present the socioeconomic indicators which will be established from an analysis of the field data, and will not be repeated here. The principal field method for data gathering will

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\(^5\) Matos Mar: personal communication (Jan., 1984).
\(^6\) ________________________________
be ethnographic, as practiced in sociocultural anthropology. Intensive observation, enumeration and description will be made by resident fieldworkers, with quantified measures introduced whenever possible. Some of the measures are indicated in the protocol (p. 10).

Besides working with a census of basic social, cultural, demographic and economic information from the entire population, qualitative scaling of attitudes and perceptions will be used to obtain basic need satisfaction, quality of life, well-being, future outlook and aspirations, and some economic information. In some cases, standardized interview schedules will be used, such as the 24-hour diet recall interview. Quantified measures will be made in the calculations of energy inputs, flows, outputs and exports;\(^7\) food consumption, its quality and quantity; household budgets, maintenance funds, surpluses and resources usage in general\(^8,\)\(^9\). Base maps will be used to plot crop cycles, types, quality and areas of effluent irrigation, and so forth. Plans of house types will present the functions and use of space. The small population also makes possible longitudinal case studies of individual and family life cycles by means of life history interviews\(^{10}\).

A guideline of topics to be investigated is presented below. The list is by no means to be taken as exhaustive or final. Some of the information


\(^{10}\) Matos Mar, op. cit:167-225
appearing in the list will be obtained with greater ease and more rapidly (as e.g. by straightforward census enumeration), than other kinds of information, which may require continual monitoring or the establishment of a long-term, of relationship rapport between the field investigator and his informants. Other classes of data will be of seasonal occurrence, presenting themselves only periodically for observation. It can also be expected that unpredictable and even unforeseen events will occur which will have a significant effect on the lives and health of the farming households. For these reasons, the investigation will require the continual presence of a social anthropologist and at least one assistant, who could be a local person, residing with or near the study population for a minimum of one year. The anthropologist should be an experienced fieldworker, specialized in the topics under study, and preferably bilingual in Spanish and Quechua. This anthropologist will be under the direct supervision of Dr. José Matos Mar, Director of the Instituto de Estudios Peruanos, Lima. The Associate Principal Investigator, Dr. Thomas S. Schorr (ECO), also a social anthropologist, will participate in the design of the study and on periodic visits, will evaluate the course of the study and contribute to the analysis, interpretation and presentation of the results.

Because of the diversity of data to be obtained for all the investigative sectors of the study — some requiring physical examinations and biological sampling of the study population — it would be the responsibility of the resident anthropologist to coordinate data collection with the other co-investigators and act as intermediary between the co-investigators and the study population. Data needed in common by all sectors of the investigation such as the household census, could be obtained by the anthropologist once and for all. In this way the study population will be protected from unexpected incursions or having to submit to poorly understood and unwanted, personal interventions by strangers which could lead to the rejection and termination of the entire investigation.
A Guideline of Study Topics

A. Behavioral Practices of the study population which may lead to foodstuff contamination and affect its health status.

1. Food preparation and storage;
2. Hand washing before preparing food
   - after dirty work routines
   - after excretion
3. Cleanliness of utensils for food preparation and drinking
4. Cleanliness of hands and body
5. Cleanliness of dress
6. Cleanliness of kitchen, house, yard
7. Excretory habits
   - frequency
   - toilet
   - outdoor, where?
   - use of cleansing material
8. Infant and child care, weaning methods
9. Food exchange with neighbours
10. Buying food ready for consumption in restaurants from street vendors or in the market place type (raspadillas, refrescos, bocadillos, comidas completas) frequency
11. Source of drinking water and water for cooking
12. Quantity of water used for drinking
13. Quantity (and source) of water for washing clothes
14. Quantity (and source) of water for body washing, frequency
14. Contact with sewage effluents, water quality, manner of contact, frequency

15. Contacts with domestic animals

16. Individual and group contact in the use of space during rest, eating, and daily activities

17. Home and local treatment by family or traditional practitioners of perceived health concerns; methods of diagnosis, treatment, and patient management during convalescence

18. Conditions and decision to seek professional physician's attention.

B. Sociocultural characteristics which define the population:

- **General spatial information**

  1. Topographic map of community identifying all built structures, use of space, land-form modifications, routes and types of communication, energy sources and land use. Inhabited structures should be numbered and indexed with reference to the census. Recent aerial photographs (Jan. 1984) will be used in the field and historical depth information interpreted where indicated from earlier flight lines.

- **Specific census, interview and observational information:** (see household and individual card forms, Annex I, to coordinate the indexing of all data)

  2. Ethnic identity

  3. Location of residence
4. Provenience and length of time of residence in San Juan
5. Reasons for moving to San Juan
6. Level of education
7. Languages spoken, most often used
8. Information access: literacy, radio, television, social groups memberships, etc.
9. Marital status: married, single, separated, widowed, consensual union
10. Children: in order of birth, sex, age, alive or decease, legitimacy status
11. Residential occupancy: who resides in the house? Kinship relationship with head(s) of household
12. Family type: incomplete, nuclear, extended, combined
13. Kinship system and active network inside San Juan and with other communities, economic implications
14. Compadrazgo and other ritual networks, economic implications
15. Association memberships, type and purpose, economic implications
16. Religious affiliation; degree and type of activity
17. Visiting customs: who do you visit, locally, elsewhere, for what reason, how frequently, for what duration, who accompanies you? Who visits you, etc.?
18. Concubinage, amount of support contributed, income derived
19. Perceptions (attitudes) of health illness and risks: most common, culturally perceived disorders
20. Access to, and use of health services

21. Food preferences and methods of preparing and serving. Who is served? Quantity, quality

22. Seasonal communal observations, special occurrences and celebrations and the activities which take place

23. Life cycle management; activities surrounding birth, puberty rites, age, group identity, marriage, old age, deaths.

24. Family cycle, extension or dispersal of family activities by respectively establishing local residence on maturity of children, or their dispersal through migration

25. Selected life histories.

C. Economic Activity of the population

1. Incomes
   - from crops: vegetables, fruits, flowers, others
   - animals: milk, eggs, meat, fiber
   - total amounts and kinds produced, less that sold; traded, consumed, divided or lost = 100%
   - from economic activity elsewhere
   - other: (family budget)

2. Expenditures
   - food purchases: oil, fat, sugar, flour, meat, fish, coffee, soap, alcohol, etc.
   - water
   - education and supplies
- clothing
- utilities: electricity, telephone, fuel
- water rights
- land use rights
- contributions to absent family, associations, church, etc.
- other: (family budget)

3. Agricultural tools, mechanization and/or hand labor

4. Household apparatuses, kitchen, sewing machines

5. Transportation

6. Radio, TV, periodicals

7. Electricity in households

8. Water tank, piped water, wash stand

9. Type of house (own, rented)

10. Ownership of property elsewhere, type, location

11. Household animals

12. Crops cultivated, kind, frequency, reason, location of fields, quality of water used to irrigate them, frequency of irrigation

13. Common pests in cultivation and farm animals and methods of control, possible contamination by agricultural chemicals (e.g., pesticides)

14. Labor arrangements and capitalization in cultivation:

partnerships, kinship or compadrazgo relations, work responsibilities of family members by age, sex, type of work done and its scheduling; loans, hired help, sale of crop before harvest, sale after harvest, to whom, where? Method of dividing income
15. Operation of the irrigation system: regimen of apportionment, quality of water, location and purpose of use; system of authority, rules and decision making in water control determining scheduling of availability, quantity, quality during the crop cycles; causes and effects of unscheduled variations in water supply; the occurrence of conflicts in water use and methods for conflict resolution.

Instruments and Techniques

The data gathering instruments; forms, census tracts, questionnaires, schedules for recording observations and measurements, budget records, base maps and the like, will be devised during the initial six months of project preparation. In many instances, these instruments and the techniques for their use already exist for Lima populations very similar to those of this study, as amply presented in *Las barriadas de Lima*⁹. As an example, Figure 1 is a facsimile of the census tract used in *Las barriadas* (p. 228). However, it will be necessary for all co-investigators to coordinate the development of a unified and compatible set of instruments with which the necessary data can be obtained in the most efficient manner.

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⁹ Matos Mar, *op. cit.*
Censo General de las Barriadas Marginales

| NOMBRE Y APELLIDOS (COMENZANDO POR EL Jefe DE LA FAMILIA Y CONSIDERANDO A TODOS LOS QUE DUREN EN LA VIVIENDA) | PARENTESCO CON EL N° 1 | SEXO | EDUCA | LUGAR DE NACIMIENTO | EDAD DE LLEGADA A LA BARRIADA | OCUPACION | LUGAR DE TRABAJO | SALARIO | AÑO DE NACIMIENTO | AÑO DE LLEGADA A LA BARRIADA | RELACION
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PREGUNTAS PARA EL JEFE DE FAMILIA

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2. ¿ Es propietario de la vivienda que ocupa? Sí [ ] No [ ]
3. ¿ Pertenece a la asociación? Sí [ ] No [ ]
4. ¿ Esta enfermo? Sí [ ] No [ ]

5. POR CUÁLES MOTIVOS DECIDIÓ RADICARSE EN LIMA?

6. POR CUÁLES MOTIVOS DECIDIÓ RADICARSE EN LA BARRIADA?

7. BARRIADA:

8. CENSADOR:

9. FECHA:

Modelo de la Ficha Censal Utilizada