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CHOLERA CONTROL THROUGH ENVIRONMENTAL SANITATION

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Basic Considerations

by

W. E. Wood<sup>a</sup>

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Note: The series of documents bearing the symbol WHO/Env.San/- has been discontinued and replaced by the new series WHO/EH/-.

<sup>a</sup> Sanitary Engineer, Community Water Supply unit, Division of Environmental Health, WHO, Geneva.

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CHOLERA CONTROL THROUGH ENVIRONMENTAL SANITATION

INTRODUCTION

Dr John Snow, in 1855, published the second edition of his book "On the Mode of Communication of Cholera". In this he established, for the first time, the method of transmission of the disease. The key sentence in his introduction reads "The morbid material producing cholera ..... must be swallowed .....". At the time of publication, this was a new concept; subsequent experience has proved its entire correctness.

In 1864 Louis Pasteur showed that cholera was caused by organisms, which he called "microbes", and these were identified by Robert Koch in 1884.

Thus, for the last century, it has been known that if the causative organism could be prevented from reaching the mouth then cholera would not be contracted. The vibrio, as we now term it, must be kept from food and water. The protection of food and water supplies depends upon environmental sanitation measures, and wherever these measures have been successfully implemented the spread of cholera has, to a large degree, been controlled.

This fact is widely recognised, and hardly any work on cholera fails to point out the importance of environmental sanitation as a method of control. Unfortunately a rider is usually added to the effect that sanitation measures are likely to be so expensive, and take so long to implement, that they must be regarded as an ideal unattainable in a measurable time.

There may be some small degree of truth in this attitude, but it is felt that the difficulties are often exaggerated and the potential benefits underestimated. It is believed that properly planned and energetically executed programmes of environmental hygiene can and should be initiated and pursued, and that these would make a greater and more lasting impact on the control of cholera than any other measure could hope to do.

It can hardly be disputed that the virtual disappearance of cholera from those areas in Europe and America which formerly were periodically ravaged by epidemics is due, almost entirely, to the improvement of environmental conditions in those countries. There is no reason to suppose that improvements of sanitary standards would not have equally effective results in those countries where cholera is still an ever present threat.

Such measures will call for money, manpower and time. The expenditure of money in this direction can prove a profitable economic investment - possibly the best investment a country can make. Manpower is nearly always available, but the recruitment and training of the right type of personnel is a problem which must be faced. Time will always remain a vital consideration; there is, however, no justification whatever for postponing action on the grounds that results may be long-term rather than immediate. In any case there are nearly always short term improvements that can be put in hand as an interim expedient pending the introduction of more permanent control measures.

It is believed that an awareness of the problem, comprehensive planning and vigorous implementation by the authorities concerned would make a marked impact in a measurable time on the problem of cholera control.

ENVIRONMENTAL SANITATION

Environmental sanitation is the discipline of protecting man from the natural or man-made hazards which surround him. It covers a wide range of factors - pollution of air, water and soil, excessive noise, extremes of temperature are examples - but in this paper only those aspects which relate to the transmission of diseases such as cholera will be considered. Briefly these include the hygiene of water and food and the safe disposal of excreta and other wastes.

It is well known, and has been amply proved that, unlike other measures of control, environmental improvements carried out for the reduction of cholera are equally effective against many other diseases, so that additional benefits are immediately apparent from the expenditure of money and effort. Typhoid, dysentery and other water-borne and parasitic diseases are reduced by the provision of safe drinking water; facilities for personal and domestic cleanliness can reduce scabies, skin infections, trachoma and other filth-connected afflictions; hygienic measures in food production, preparation and handling can prevent much bacterial and parasitic infection; controlled disposal of excreta and household refuse can reduce flies, rats and other disease vectors.

It is not intended, in the present paper, to discuss at length the financing and construction of new water supply or sewage disposal facilities. It should be mentioned, however, that WHO can and does provide technical assistance to governments in this direction, and has helped in obtaining grants and loans from financing agencies. In the case of larger towns especially, a waterworks can be not only an economic but also a financial asset; properly managed, it can often generate sufficient income to cover not only running costs but repayment of construction capital and interest. Indirect benefits to industry, tourism, increased land and building values, fire protection and amenities can make a municipal water supply a most attractive investment. Smaller town and village supplies may require subsidising, but by simplification of design and use of local materials the cost may be kept to a minimum, and there are sources of international assistance which may further contribute to a reduction of the capital investment necessary.

Although, in all too many countries, there is an immediate and urgent need for waterworks and sewerage construction, there are nevertheless other measures of environmental improvement that can be undertaken without a large investment of capital and some of these are outlined below. Each will be considered in three stages: firstly, the normal precautions which should be observed at all times if water or food borne infection is to be avoided; secondly, the preparatory measures to be taken when an epidemic threatens; and thirdly, the emergency itself, and the special action necessary to deal with the situation as it arises.

Environmental Sanitation Organizations

The key to all environmental sanitation programmes is the trained and experienced professional sanitary engineer supported by sanitarians and other environmental health staff. There is a shortage of such men throughout the world, and it is essential that the most efficient use possible should be made of their services.

National planning should take this point into consideration, and ensure that professional staff are deployed in such a way as to use their surveillance and advice to maximum advantage. They should have adequate supporting personnel, and care should be taken that their skill and experience is not misused in duties which could be performed adequately by less qualified staff. As examples, there are many instances of sanitary engineers who spend an undue proportion of their time in training sanitarians, an important task, but one which might equally well be performed by a good sanitarian-tutor. In other cases, due to insufficient support, these engineers have to do their own surveying, take samples of water and food, and do other routine duties for which a subprofessional would be equally suitable. To some extent, the same applies to other grades also and it is not uncommon, in countries where

trained sanitarians are inadequate in number, for these men to be employed on clerical duties, especially in rural areas.

Another point to be considered is the fact that many small municipalities and townships are unable to employ adequate engineering staffs, and that such communities are equally liable to become foci of cholera as are the bigger cities. Surveillance and guidance from sanitary engineers from government, state or regional authorities is most important.

In practically every country the Ministry of Health, or its equivalent, is responsible for dealing with epidemics as they arise. It is obvious that it should also concern itself with the operation of environmental sanitation in normal times to ensure that conditions favourable to the outbreak and spread of disease do not build up. Setting of standards, and surveillance to ensure the maintenance of these standards, should be the Ministry of Health's constant concern. It can only do this through an adequately staffed and efficiently run sanitary engineering division. The weaker the organization and staffing of sanitary personnel in the towns and villages of the country, the stronger should be the Ministry division, since the responsibility will be so much greater.

Under the threat of an imminent outbreak, this function of surveillance must be intensified. Adequate powers should be vested in the Ministry of Health to bring pressure upon areas constituting a particular danger (e.g., border towns, ports or staging points on an international highway) to intensify their precautionary measures. The Ministry should also have powers, and prepare plans, to move sanitary staff from an unaffected part of the country to an epidemic area if necessary. Emergency stocks of such items as disinfectant, dosing equipment, water testing apparatus and the like should be built up and held at strategic points. The organization of intercountry assistance is referred to later.

If national or local committees for cholera control are set up, it is strongly recommended that a sanitary engineer should participate. It is important that all the professionals who will have to work together in an emergency know details of each other's planning, so that co-ordination can be arranged in advance. It is also important that such aspects as transport, laboratory testing facilities, temporary stores, labour recruitment and the like be worked out to avoid confusion later. When an epidemic actually occurs both doctors and engineers will be fully occupied with the emergency, and confusion at that time as to their respective functions and support services could lead to serious delays.

In such an emergency, the traditional partnership between doctor and engineer will be intensified, each having his part to play in the control of the epidemic and the protection of those at risk. Careful planning in advance will facilitate their respective functions; each will act more confidently and efficiently knowing that his colleagues and allies are similarly undertaking their responsibilities. Certain aspects will require especially close co-ordination, e.g., the tracing and identification of the vehicle of transmission of a particular outbreak.

#### Community Water Supplies

In any programme of environmental sanitation for cholera control, the first consideration must be the safety and adequacy of the water supply. This is so, not only because of the potential role of water in the transmission of infection, but also because other measures of control, e.g., food sanitation, depend materially on the existence of safe water.

It is, unfortunately, all too true that a large proportion of the population in many developing countries have to rely on supplies which are neither safe nor adequate. It is believed that until this position is remedied by the construction of abstraction, treatment, storage and distribution works, control of cholera and other waterborne diseases

can never approach completion. This most involved and important matter forms too large a subject to be discussed in these brief notes.

Wherever a system of piped water exists, or is constructed, there immediately arises a problem of maintenance and operation. It cannot be too strongly stressed that this is as important as the construction itself; a badly run works, serving contaminated water, can be a most rapid and far reaching mechanism for infecting the whole body of consumers with the very diseases which it was intended to control.

Managing a waterworks requires trained operating staff and constant vigilance to ensure that the water produced fully meets public health requirements. The considerations are manifold, and cannot be fully entered upon here. WHO monograph no. 49 on "Operation and Control of Water Treatment Processes", for instance, deals with one aspect only of water supply, and is generally accepted as authoritative advice on treatment processes. Another WHO monograph, no. 42, is entitled "Water Supply for Rural Areas and Small Communities", and this deals more broadly with the problems of small water works.

A few points in the maintenance of quality standards are worth emphasizing, since these are commonly neglected and are potential sources of trouble.

First, is the absolute necessity of sanitary protection and cleanliness in anything to do with water supply. Examples include protection of water sources, sterilization of new or repaired mains, regular flushing or swabbing of mains in use, cleaning of reservoirs, etc. All possible steps should be taken to reduce or prevent periods of low or negative pressure, as when parts of the system are shut off low pressure may allow the entry of ground water into the mains with the virtual certainty of contamination of the supply, or back-siphoning which has a similar effect. Intermittent supplies are particularly vulnerable in this respect, and every endeavour must be made to ensure continuity of service. Provision should be made for adequate latrine and washing facilities for all staff coming into contact with the water, or with surfaces which could, in turn, transmit infection to the water.

Secondly, the need for regular quality testing and, even more importantly, a system to ensure that remedial action is taken whenever tests show that the quality is falling below standard.

A third point is to ensure, by medical examination, that staff coming in contact with the water or with waterworks equipment are not themselves suffering from or carriers of diseases which could be waterborne.

Fourthly, is the need for regular and systematic leak detection and control. Even the most perfectly laid new mains are liable to leaking joints; older mains may lose a very considerable percentage of the water which they carry through corrosion, disturbances due to ground movement and other causes. Leaks in the system lose water, often desperately needed by the consumers, but more importantly are the the points at which infiltration occurs.

A further point worthy of comment deals with the disinfection of water by chlorine or other chemical. It cannot be too strongly stressed that the mere adding of chlorine to dirty water cannot be relied upon to produce a safely potable result unless tests show that an adequate residual is obtained. Under normal working conditions chlorination forms a valuable additional safeguard to a water supply that has undergone filtration or other treatment. In an emergency, doubtful, unfiltered, supplies may have to be resorted to in the absence of safe sources in which case chlorination is absolutely essential, but under normal circumstances it should be the first priority to ensure that the water is safe to drink unchlorinated, and then disinfect it as a second line of defence. In other words chlorination is a valuable emergency measure, but needs to be carefully

applied to be really safe.

Chemical disinfection of water is particularly prone to human error, and close surveillance is required if reliance is to be placed on this form of treatment. When chlorine in the form of powder (hypochlorite or bleaching powder) is used the efficiency can be greatly reduced by bad storage or incorrect mixing; the dosing must be carefully controlled - if too dilute it is ineffective, if too strong consumers may be driven, by the taste in the water, to unchlorinated sources thereby nullifying the whole effect of the treatment. When the source water contains excessive oxydisable material the disinfecting qualities of the chlorine may be neutralized. Hence reliance on chlorination as a sole method of treatment, capable of rendering any water source safe, may result in a false sense of security.

This applies equally to the village well, spring or tank as to the piped city supply. During an epidemic, an open well may be treated with a cartridge or drip feed supply of disinfectant, and may give temporary safety. A number of devices of this nature are described in background document WHO/CWS/RD/69.1 - "The Village Tank as a Source of Drinking Water". For normal use, reliance should not be placed solely on such treatment; in each case, accepted methods of sanitary protection must be applied to such sources.

Precaution against a threatened outbreak, will include the identification of all sources, public and private, which are, or may be, used by the public. These sources should be checked for sanitary defects and should be tested for bacterial contamination. Where supplies are shown to be of doubtful safety, they should either be protected, closed, or (where both these expedients prove impossible), warnings should be given to consumers against drinking the water.

Open surface water sources should always be regarded as unsafe unless adequate treatment is given. There is no point in wasting time and testing materials in examining such sources. Properly protected deep groundwater sources will usually prove safe but should be tested as a check. Shallow ground water sources may be contaminated and the water unsafe even though the top is adequately sealed and a hygienic pump installed - if the well is an open one the hazard is obviously increased considerably.

To test water for the presence of cholera vibrio is a difficult and lengthy process and is usually impracticable under the circumstances. Hence the normal procedure is to examine samples for evidence of faecal contamination by the standard test for coliform organisms and to assume that cholera is to be expected wherever such contamination exists. The use of portable membrane filter testing apparatus will be found very useful for an exercise of this sort but cannot be efficiently used on dirty samples. Results can be quickly obtained, a high degree of skill is not needed in its operation, inadequate laboratory facilities are not overstrained, there is no problem of transport of samples since testing is done on site, and the equipment is not unduly expensive.

Probably even more important than the membrane filter apparatus is the portable equipment for testing chlorine residual, using ortho-Tolodine or DPD as an indicator reagent. In piped supplies particularly it is the quality of the delivered water which is vital, and the presence of an adequate chlorine residual at the point of draw-off is the best guarantee of its safety. Simple colorimetric test kits should be held in sufficient number; these may be manufactured easily and cheaply within a country, as has been done in India (details may be obtained from the Central Public Health Engineering Research Institute, Nagpur, if required).

Test kits, both membrane filter and chlorine residual, together with a good supply of membranes, growth media and indicator reagents should be held against an emergency, and as

many of the staff as possible should be instructed and practised in their use. Stocks of disinfectant, such as chloride of lime or high-test hypochlorite and dispensing devices should be built up, plans should be made for alternative sources of water should the existing ones prove unsafe, arrangements should be worked out for carrying water by tanker or in other suitable containers, and for vehicles to transport these should it prove necessary. Above all, there should be close supervision of all water supplies to ensure that all possible sanitary precautions are being taken, and that staffs are fully aware of their special responsibilities.

If an epidemic does occur, it will be necessary to ascertain the source of the infection. This will be done in close liaison with the medical authorities, but precautionary measures should be taken immediately without awaiting the result of epidemiological investigations, i.e. the water supply should be regarded as suspect until it has been proved otherwise. Normal chlorine dosages should be increased - a residual of 0.5 ppm is suggested. Wherever possible, an infected source should be immediately closed, and its use forbidden to the public. In those instances where there is no practical alternative source, either water will have to be brought from outside by tanker or temporary pipeline, or temporary treatment and a high dosage of disinfectant must be given. Where, for instance, the danger spot is a river or lake which cannot be closed or treated, then temporary treatment should be given to small quantities for drinking and cooking purposes, or individual sterilizing tablets given to those who are forced to drink from this source. Actions such as these must be supported by an information service to the public (referred to later) and it may even be necessary to enlist the assistance of the police to prevent people from drinking infected water. Constant and systematic testing of all possible sources in the affected area must be carried out to identify infection before anyone contracts the disease. Advice to boil all water for drinking and food preparation may be issued, but this should never be considered a substitute for preventive measures, since such advice will never be completely followed.

### Excreta Disposal

For the transmission of cholera, it is necessary for the vibrio from the excreta of one person to be conveyed to the mouth of another. Every endeavour must, therefore, be made to prevent infected matter from being washed into water (either above or below ground) which will later be used for drinking, from coming into contact with food, from being handled, and from being carried by flies or other pests.

The most efficient way of removing sewage and rendering it harmless is through a system of sewers and a sewage treatment plant. In large cities, this is the only safe way, but the initial construction is expensive. New construction and the normal operation of sewage disposal works are highly important and again are large subjects in themselves, beyond the scope of this paper.

For smaller community units, various types of disposal (e.g. pit latrines, aqua privies, septic tanks) are described in WHO monograph no. 39, "Excreta Disposal for Rural Areas and Small Communities" both as regards their construction and maintenance in sanitary condition. This monograph also deals with methods of collection and disposal of night-soil from bucket latrines, and this operation probably presents the greatest hazard for cholera transmission especially in crowded areas.

Danger arises first among those employed to handle the buckets and other containers, and to work on the disposal site. Washing facilities should be provided, and the men concerned should be encouraged to use them, both at the end of the day's work and before eating their food. Men engaged in any aspect of excreta disposal should be given priority in any immunization programme.

Cleanliness of carts and containers becomes doubly important when an epidemic threatens if fly transmission is to be avoided. Leaking containers should be scrapped, covers should be checked, and facilities for washing down carts, containers and tools at the end of the day's work provided, remembering that the wash water itself will become contaminated and must be disposed of properly.

During an epidemic, additional supervision must be given to avoid spillage and careless handling. By education and enforcement as appropriate, casual defaecation by the public must be prevented, and this may have to be supported by the construction of temporary public latrines. Disposal of excreta from hospitals, clinics, or other particularly dangerous points must be treated with special attention. Adequate stocks of chloride of lime or other powdered disinfectant should be available, and should be unsparingly used wherever flies may be attracted to excreta or contaminated surfaces. Above all, the disposal point for night soil must be sited where no possibility exists of contamination of water sources, and must be covered with earth immediately after deposition.

### Food Hygiene

Food may become contaminated in several ways - at source, during transport, manufacture, preparation or serving. It is virtually impossible to supervise all these stages, or the numerous people involved in them, so a concentrated effort must be made at those places where a single human carrier, or unhygienic practice at one point, can infect a large number of consumers.

The first such point is the field in which vegetables which are eaten raw are grown. In many parts of the world, it is the custom to use raw night soil to fertilize such crops, and the dangers of such a practice are obvious. Methods of reducing these dangers are discussed in Monograph 39 (referred to earlier) and include controlled composting, detention of excreta in tanks to permit "die away" of pathogens, anaerobic digestion and other processes. When an epidemic threatens, the use of excreta as fertilizer on food crops should be prohibited.

In the event of an epidemic in a large city, control measures may be carefully carried out, and yet be vitiated by the import of market produce from the surrounding countryside where the supervision of hygiene is ineffective, where infected excreta may have been used as fertilizer, or where a contaminated stream or pond has been used for washing vegetables. The banning of all such imports, (the only really safe precaution) is drastic and may create a secondary problem of feeding the citizens. An alternative, which is not unduly expensive, is the setting up of control points where all fruit and vegetables entering the city can be immersed in wire baskets, into tanks containing a weak solution of a disinfectant such as iodine that will not affect the character or taste of the produce. The construction of these tanks and simple equipment should be undertaken before an epidemic actually occurs, i.e. at the "threatening" stage. It must be emphasized, however, that precautions of this nature cannot be considered 100% effective.

Food manufacturing establishments, especially of food to be eaten without subsequent cooking, e.g. sausages, mineral water, ice, should be listed, inspected, and subjected to similar precautions to those described for waterworks. Above all, their water supplies should be tested regularly. Particular attention should be given to the handling of the food after processing. A common source of infection of canned goods is from cooling water which, since in theory it does not come into contact with the food, may be untreated.

Each food preparation process requires its own special precautions, but in general, cleanliness, adequate latrine accommodation and subsequent handwashing facilities for the workers, and regular medical inspection of staff handling food, should be rigidly enforced.

Establishments serving food, particularly those catering for travellers, should be listed and regularly inspected; a system of licensing facilitates control. Hygienic



precautions, in addition to those referred to in the previous paragraph, will extend to cooking utensils, cutlery and crockery, table and other surfaces, washing up water and drying cloths and numerous other features. Latrine and washing facilities should be provided for customers as well as for staff.

In all establishments (including markets) where food is prepared or sold, a continuous battle of extermination against flies, cockroaches, rats and other pests must be waged. Both buildings and open spaces must be kept clear of refuse in which these could feed or breed; refuse containers should be covered and emptied regularly.

#### Refuse Collection and Disposal

While it is not suggested that house refuse, or the wastes from commercial or industrial premises can (except in rare instances) harbour cholera vibrio, such wastes can and do attract flies and rats which, in turn, can act as links in transmission chain of the disease. Open piles of refuse must not be allowed to accumulate near to dwellings, particularly within cities, but the wastes must be removed as fast and as far as possible and properly disposed of in accordance with accepted sanitary practice. Spraying with insecticides will help in the control of flies, and every endeavour made to kill rats wherever they may be found.

#### Municipal Hygiene

During an epidemic, when additional care has to be given to the matters already described in this paper, there are many pressures on sanitary authorities, their professional and labouring staffs. The hygienic burial of victims of the disease may be one instance.

In consequence, routine duties, such as refuse collection and street sweeping, may be neglected. Every endeavour should be made to see that municipal hygiene measures of this nature are not allowed to suffer but are, rather, improved during the emergency. The particular effect of any one of such measures may be difficult to assess, but it is reasonably safe to assume that the sum total of all precautions and the general standard of municipal cleanliness cannot but have an influence upon the over-all position and improve the efficiency of specific control measures.

#### Information and Health Education

All environmental control measures must be supported fully by the public which they are designed to serve. It is most important to obtain their willing co-operation, though there may be occasions when this has to be supplemented by enforcement measures. The liberty of the individual to take risks with his own health must be subordinated to the general health of the population, which may be endangered by the individual carrier or patient.

Co-operation may best be secured by an understanding by all concerned of the reasons for emergency measures which have to be taken. Obedience to an order forbidding the use of a certain water source, for instance, is more likely to be obtained if the dangers of drinking contaminated water are understood.

Even more essential is the necessity of making food handlers, hotel employees, municipal staffs and other workers understand why they need to carry out the respective precautions appropriate to their own duties.

Close liaison with the medical authorities in the preparation and dissemination of public information during, and possibly even more importantly, before an outbreak is considered one of the most vital of the functions of the environmental sanitation

authorities, both at a national and local level.

### Intercountry Co-operation

Cholera is not a national problem alone, and no quarantine or other methods have yet been devised which can be guaranteed to stop an epidemic at a country's borders. Hence every national authority must be vitally concerned with the efforts of its neighbours in controlling the spread of cholera, and it should be willing to co-operate with and assist those who may, in fact, be fighting a battle elsewhere which might otherwise be taking place in its own territory.

At the time of an actual outbreak, such co-operation may be impossible to arrange. To be effective, it must have been planned in detail beforehand. The following is a suggestion as to one way in which this could be accomplished.

As stated earlier, sanitary engineering staff is scarce in almost every country; during an epidemic they will be hard pressed and inadequate in numbers. If a number of adjoining countries would each arrange for one or two of their professional staff to train together with their neighbouring counterparts as a team, on the understanding that in an emergency in any one country the team mates from the others would be immediately sent to work under the leadership of the engineer of the country at risk, they would constitute a well trained "fire fighting" force ready for prompt action. Each member would have his own tools, e.g., water test kit, would speak the same language, would know his team mates and would have been trained in the same measures. If, in addition, the same countries would carry emergency stocks of such items as disinfectant, and make these available in the same way to its neighbours in need, the value of the team would be further enhanced.

Details and the mechanism would have to be worked out well in advance, but it is believed that the team concept is feasible, and could be extremely valuable if, and only if, prompt action with the minimum of red tape and formality could be guaranteed.

### Conclusion

In view of the present serious cholera situation the present paper, setting out the basic considerations of cholera control through environmental sanitation, has been prepared in advance of a more detailed work plan on the same subject which it is proposed to issue in the near future.

To sum up, those points which are considered of the most vital importance are reiterated: firstly, that there is no substitute as yet for basic sanitation facilities as a first step to minimise chances of epidemics; secondly, the necessity of planning well ahead of an emergency so that, if and when it comes, everyone concerned may know exactly what is expected of him; and thirdly, the maintenance of a close partnership between the two professions who will together be responsible for cholera control, the medical doctor and the sanitary engineer.

Some Appropriate WHO Publications References:

International Standards for Drinking Water WHO Geneva 1963

WHO MONOGRAPH SERIES

- No. 39 Excreta Disposal in Rural Areas and Small Communities  
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- WHO/CWS/RD/70.1 "Biological" or "Slow Sand" Filters
- CWS/70.5 National Rural Water Supply Programmes, ECA  
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