

# Assessing the Impact of the Introduction of Reverse Osmosis Water on the Incidence of Chronic Kidney Disease of Unknown Etiology in the North Central Province of Sri Lanka

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## Abstract

The decline in the incidence of Chronic Kidney Disease of Unknown Etiology (CKDu) within Sri Lanka's North Central Province (NCP), as documented by Ranasinghe et al. [1], represents a very positive trend. According to the authors' 'In NCP provision of RO plants commenced after 2011 and the decline in the incidence of hospital diagnosed CKD/CKDu was seen in 25 of the 29 Divisional Secretary Divisions when more than 20% of the families received access to drinking RO water project'. This departure from previous studies, particularly the research conducted by Rajapaksa et al, which indicated a significant increase in the prevalence of CKDu by 22.9% in 2016 among the population of NCP, underscores the evolving epidemiological landscape. Additionally, Ranasinghe et al, identify a correlation between the diminishing rates of CKDu observed between 2015 and 2020 and the proliferation of RO water treatment plants across the districts commencing in 2011. While this correlation is noteworthy, caution is warranted in attributing causality. My interviews with people in the affected regions reveal that the transition to clean water occurred much earlier; with individuals beginning to utilize spring water, rainwater, and bottled water retailed in shops. This shift in practice introduced the commodification of drinking water and the idea of consuming clean water as a way of was solely responsible for the reduction in CKDu incidents. This paper critically examines the assertion that introducing RO water has a positive correlation with the decline of CKDu incidents in the NCP indicating that RO water supply is accountable for the decline in CKDu incidents in the NCP.

## 1. Introduction

### 1.1. Anthropology of Drinking Water

This research by Ranasinghe et al and de Silva contributes to the ongoing discourse surrounding drinking water and CKDu in Sri Lanka. As water research assumes increasing significance within anthropology, it reflects the growing global imperative to ensure universal access to clean and potable water. Anthropological research has examined water as a resource as it relates to the distribution of power to agriculture the establishment and expansion of communities and settlements, and rituals [1-9].

Anthropological research has shown that, in Sri Lanka, water more than land is the resource factor that constrains and shapes social order. Taking a Wittfogelian cultural and ecological perspective,

Leach describes how, within a particular human-made ecological environment in Pul Eliya in the NCP, water with land and climate- the trio of topography- determines what people do: "It is the total water supply available to a community which sets a limit to the area of land that may be cultivated and hence to the size of the population." The control of water determines economic and political influence and power structures throughout the community. Further, "the primary economic requirement for a villager is not that he should be the owner of the land, but that he should be a member of the village with rights to a share in the water of the tank [reservoir] and...a share of land is primarily a share in tank water" [6:98]. Water rights, rather than land rights, explain the many peculiarities of the traditional land tenure system in NCP Anuradhapura villages. Likewise, the priority given to access to

water is central to modern-day hierarchies of relationships and social inequality, which bear on the social epidemiology of CKDu.

Anthropologists have long been interested in the cultural and social factors affecting clean drinking water and community interventions promoting its use. Most work has focused on cultural and social relationships, structures, and organizations in communities where such interventions have occurred. It has examined impediments to the provision of clean water and the acceptance of those programs by the local communities.

One of the earliest anthropological studies of an intervention on drinking water was Wellin’s two-year ethnographic fieldwork in rural Los Molinas in Peru. It focused on a program advising women to boil water before drinking [10]. Most people in that rural town did not boil drinking water, and rates of typhoid fever were extremely high. The intervention was developed on the assumption that, if the women were convinced of the health benefits of drinking boiled water, they would change their practice accordingly. After his research, Wellin found that the intervention was an almost complete failure, as the number of women who regularly boiled their drinking water rose from fifteen to twenty-six in the village of 200 households although it is a 73% increase, an increase of eleven families over two years of intervention by Nelida, the local health worker charged with implementing the project. However, as advocated by the intervention program, it did not match the cultural expectations of the people of Los Molinas.

In the 1980s, twenty-seven years after the Los Molinas study, the government of Sri Lanka and UNICEF established a similar intervention, promoting the boiling of drinking water as a remedy for the high levels of infant diarrhea in Sri Lanka. Nichter

observed that the health messages imparted by the intervention program ran counter to the country’s cultural context and were not received well by the community. In Sri Lanka, drinking water needs to be examined in the context of Ayurvedic and indigenous traditions, where the dichotomy between hot and cold and the balancing of the humors in food is prominent. Water is seen from different perspectives as light (boiled water consumed by patients) or heavy (regular water defined as “fresh,” “full of life,” and “having strength”) [11]. In contrast to heavy water, boiled water is associated with illness and is seen as lifeless and weak. Nichter concluded that, in Sri Lanka, the advice to drink boiled water was understood in terms of illness and vulnerability. Introducing a health message as simple as drinking boiled water requires careful analysis of folk health concepts before implementing behavioral interventions. In the context of introducing RO water, it is helpful to explore the cultural and behavioral elements that have influenced the widespread acceptance of RO water in the CKDu endemic communities of the NCP. Understanding what drives individuals in the NCP to embrace RO water as their primary drinking source is essential for informing future initiatives and interventions. It is truly remarkable to observe the significant reduction in CKDu incidents in the NCP as given by Ranasinghe et al. published in BMC Nephrology. Ranasinghe et al. imply that the decreasing incidence of hospital-diagnosed CKD/CKDu in the North Central Province of Sri Lanka is solely due to the provision of drinking water reverse osmosis plants. The findings of this article are quite in contrast with the findings of the 2016 article 'Chronic kidney disease of unknown etiology in Sri Lanka' by Rajapakse et al., which noted that the prevalence of CKDu in Sri Lanka varied across districts, with some areas reporting rates as high as 22.9%. The data quoted by Ranasinghe et al to support their findings is limited, but is summarized in Table 1 and Figure 1:

| Year                           | 2015  | 2016  | 2017  | 2018  | 2019  | 2020  |
|--------------------------------|-------|-------|-------|-------|-------|-------|
| CKD/CKDu incidence Rate        | 329.4 | 381.9 | 276.6 | 187.4 | 175.0 | 103.3 |
| % Families receiving RO water. | 13.9. | 33.2  | 49.2  | 64.5. | 67.0. | 68.3  |
| Correlation r =.23             |       |       |       |       |       |       |
| Source: Ranasinghe et al. 2024 |       |       |       |       |       |       |

**Table 1: Incidence of CKDu and Supply of RO Water in Anuradhapura by Year**

Although the published data lacks information regarding the total population at risk for each year and the exact number of new cases of CKD/CKDu, the calculated incidence rates suggest a gradual but steady decline in CKDu cases over the years. A plausible factor behind this change is the supply of RO water as an alternative form of drinking water. Pearson’s correlation is  $r=.23$ , a weak correlation, showing that the change is not fully explained and Polonnaruwa districts as it has many other factors that may have triggered the decline of CKDu rates. These factors, which are not taken into consideration in the article, contributed to people’s drinking water attitudes and behavior and people’s acceptance of RO water as the medium of drinking. This paper is based on interview data

collected in the Medawachchiya and Kebethigollewa District Secretariat Divisions (DS Divisions) within the Anuradhapura District of Sri Lanka in 2013 and in Medirigiriya in Polonnaruwa district in 2019. It is important to note that the detailed interview data is not publicly available due to its sensitive nature, as personal information was provided by respondents who do not wish for their identities to be revealed. However, this data is accessible from the corresponding author upon reasonable request.

Both areas in which the research was carried out encompassed old villages (Purana Gam), government-established agricultural settlements (also referred to as colonies) dating back to the

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1930s–1950s, and Vedda villages. Following consultations with community leaders and DS Office personnel, 14 villages were selected for the study, representing the diverse community types. Eight research assistants (four in each area) carried out qualitative and participant observation methods, conducting 100 open-ended, in-depth interviews, and 400 semi-structured ones. Participant observation involved immersion in daily activities, household and agricultural tasks, and community gatherings and discussions across two villages.

### **The Field Study Aimed to Explore:**

1. Community perceptions of CKDu and its social, cultural, and political implications.
2. How the community viewed RO water as a new source of drinking water and the use of shallow wells and tube wells for other water uses.
3. The cultural, behavioral, and lifestyle factors (including dietary habits and agricultural practices) associated with the disease and RO water use.
4. How the community explained the disease's causation and its relationship to shallow wells and tube well water.
5. Individuals' experiences of the disease and its physical manifestations and how those were affected by drinking RO water.
6. The strategies employed by communities to address the challenges posed by CKDu.

The fieldwork spanned six months from February to July 2013 and six months in 2019. Interviews were conducted in Sinhalese, and the Faculty of Medicine, University of Peradeniya's ethical review committee granted ethical approval for the overall project. People cannot become beneficiaries of RO water unless they use the RO water given to them by the government. My research shows that in villages where RO water is provided, many households continue to use natural spring water. Therefore, other factors may have contributed to the decline. New water use practices reported in other countries show that people would not adopt them unless they were confident in them. It is people's confidence in the project and the leadership that makes a project sustainable. People's confidence is seen as a means of participation as a vehicle for beneficiaries to choose their path to development while preserving their indigenous skills and, in an extended version of this argument, as a means of widening the choices available to them and of building capacity and empowerment through putting 'the last first' [12-17]. To the advocates of building from below, participation is a means of building the capacities of grassroots and local institutions [18]. Beneficiary participation seems to be regarded as the antidote to the well-recognized drawbacks of the centralized service delivery approach, such as its limited reach, its inability to sustain the necessary local action, its limited adaptability to local circumstances, and its creation of dependence on government institutions [19].

### **2. The Case Study of NCP**

In the NCP, the implementation of RO plants began after 2011. According to Ranasinghe et al, a notable decline in the prevalence

of hospital-diagnosed CKD/CKDu was observed in 2020 relative to previous years of 2016 – 2019 in 25 out of the 29 Divisional Secretary Divisions, coinciding with the provision of RO drinking water to over 20% of households. However, looking at the data provided in the article, shows that since 2013 well over 20% of households were provided with RO water, and in 2021 it was 68.3% of households were provided with RO water. Yet the Spearman correlation is weak as shown before showing that there should be other factors contributing to the decrease of CKDu incidents over the years.

Our analysis of data in 2021 shows that the decline in CKDu rates first became evident around 2016 around 2016 [Figure 2], although Table 1 in Ranasinghe et al shows incidence in 2016 was higher than in 2015. Subsequently, I posit that the incidence of CKDu has continued to decline since then, with the growing adoption of RO water for drinking purposes by every household as shown in [3].

Since it was first identified in 1990 in Medawachchiya in NCP, about 23% of the population of NCP has fallen sick with CKDu [20]. Not only that, but the disease has spread to bordering districts as well. Since 2013, CKDu has been linked by Epidemiologists, and the local people to polluted drinking water. When I started fieldwork in Medawachchiya in 2013, people there told me that they got the disease because of polluted water or 'kivul' water that they drank from the shallow wells and tube wells. that emitted a foul odor, had a musty taste, and appeared bluish. The new interest of the government and research findings of epidemiologists and biomedical scientists are driven by lay ideas about a link between CKDu and contaminated drinking water with foul taste (kivul). As proved later by scientists, the views expressed by people were correct [21].

With the rise in the number of CKDu patients, in 2009 , the government of Sri Lanka declared CKDu an emergent disease, with the histological appearance of the disease being tubulointerstitial, necessitating intervention from the Ministry of Health. Responding to the urgency of the situation, the government took proactive measures to cater for the ever-increasing CKDu patient population in the Anuradhapura district in NCP. The most important of the measures taken by the government included the construction of 23 nephrology clinics in the Anuradhapura District and the posting of trained nephrologists to regional hospitals and clinics in the affected areas, signifying a concerted effort to address the growing CKDu crisis the disease [22,23].

Scientists who worked on the question of causation came up with various explanations. (Jayatilake et al argued that CKDu is due to cadmium exposure through the food chain and drinking water. Cadmium gets into drinking water, local foods, and fish through the application of fertilizers and pesticides in waterlogged paddy farms and vegetable gardens. Other potential causal factors suggested by epidemiological research in the NCP include elevated levels of fluoride in drinking water, groundwater hardness, and the accumulation of heavy metals in soil due to factors such as fertilizers, pesticides, and toxins produced by cyanobacteria,

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commonly referred to as blue-green algae [21,22]. It is well-documented that drinking water serves as a significant route for the transmission of heavy metals like arsenic and cadmium [23-27]. Bandara et al. observed notably high cadmium concentrations in Mahaweli River water (ranging from 0.03 to 0.06 mg/L), sediments (1.78 to 2.45 mg/kg), and local food within CKDu endemic areas of the NCP. Findings suggested that shallow well and tube well water in the Anuradhapura District contained excessive cadmium, potentially due to irrigation water draining into shallow wells below reservoir and canal levels [28,29].

Conversely, researchers from the University of Kelaniya posited that arsenic from fertilizers, herbicides, pesticides, and glyphosate, along with the hardness of drinking water, contributed to CKDu. They demonstrated elevated levels of arsenic in local foods such as rice, tilapia fish, and lotus roots [30-32]. Additionally, scientists from the University of Peradeniya proposed a correlation between the geographic distribution of CKDu and fluoride levels in drinking water. The new interest of the government and research findings of epidemiologists and biomedical scientists, driven by lay ideas about a link between CKDu and contaminated drinking water with foul taste (kivul), provided the basis for government action and a research agenda. The construction of a new discourse around the disease defined it in biomedical terms as one caused by environmental factors.

The narrative around the etiology of the disease emphasizing the role of environmental toxins gained momentum through media coverage and political discourse [3]. This spotlight prompted significant public outcry, leading to governmental initiatives to provide alternative drinking water sources. Although empirical studies investigating the efficacy of alternative drinking water sources at the community level are lacking, some research has delved into this area through laboratory experiments and casecontrol studies [35]. Conducted a laboratory investigation to assess the impact of high fluoride levels and elevated water hardness on rats' renal and hepatic functions. They administered water samples collected from CKDu endemic regions orally to the rats and examined whether distilled water could mitigate the observed damage. Their findings suggest that early-stage kidney damage may be reversible with the introduction of distilled or low-solute water.

### 3. The Commercialization of Drinking Water

The understanding that contaminated water contributes to CKDu originates from firsthand experiences. People's observations of water's odor, color, and texture, the residues left in kettles after boiling, and the corrosion of aluminum pots when stored, provide tangible evidence supporting the belief that drinking water is the primary cause of illness. As awareness of water's role in CKDu expands, traditional water management systems, rooted in In Anuradhapura, this shift towards individualized drinking water systems entailed purchasing bottled water or buying water by the liter from water shops, as well as utilizing monthly water delivery services by private vendors. Rainwater harvesting at home and collecting water from natural springs, predominantly practiced

by low-income families, further illustrate the trend towards individualized water acquisition. Consequently, drinking water has become a commodity, necessitating financial investment and personal effort by individual households [32].

This transition has led to the emergence of businesses in urban areas where empty plastic containers are sold to those in need. In rural villages, small shops sell water in plastic bottles and larger containers. Farmers now transport water from home to irrigate rice fields and avoid consuming water directly from canals. Similarly, schoolchildren carry water bottles, choosing not to drink from school wells or nearby taps. These shifts underscore the commercialization of water in Anuradhapura, where obtaining water for domestic use requires individual initiative, financial resources, and agency. Particularly after 2008, when a WHO team commenced their research on CKDu, the local health department of the District initiated a range of actions in the villages. These included testing water quality in dug and tube wells, conducting blood and urine sample tests, and educating villagers about various preventive measures. These measures encompassed the importance of safe drinking water, the judicious use of pesticides, and the avoidance of locally grown vegetables and fish [32].

The implementation of health education initiatives, administered through village health committees known as "suvasahana kamitu," has been instrumental in this endeavor. These programs were meticulously tailored to disseminate knowledge among rural residents regarding preventive measures and the care and treatment options made available by the health ministry. Public Health Inspectors (PHIs) and midwives assumed pivotal roles in community engagement, endeavoring to effect behavioral changes in water consumption. Their concerted efforts have significantly contributed to the diminished prevalence of CKDu.

The district offices of the Medical Officer of Health took the lead in extensive campaigns aimed at educating villagers about the significance of using clean drinking water. These efforts advocated adopting RO water purification systems within these communities. The collaborative work of PHIs and midwives played a crucial role in instilling confidence among villagers, a pivotal factor in their transition to using RO water. As expressed by one informant, 'they organized meetings.' They said 'We are confident we can combat the disease. We trusted them because of their expertise in the field.' Consequently, we opted for RO water.' Another informant endorsed the effectiveness of RO water, citing the alleviation of their symptoms of burning urination after consuming it, a sentiment echoed by numerous interviewees. Significantly, 90% of respondents who had previously reported experiencing burning urination confirmed its cessation after adopting RO water consumption practices. People often commented on the odor, color, and consistency of water from wells and Tube wells and the presence of sediments. Boiling well water resulted in the formation of sediments (referred to as 'mandi') resembling cement in the kettle, eventually leading to the development of holes in kettles and aluminum pots used for boiling and storing water. A 32-year bodies when we drink it.'

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The transformation of well water, once revered for its symbolic significance and role in religious rituals, into a source of disease and mortality, marks a profound shift in perception. Sentiments expressed by informants poignantly capture this evolution: ‘We drink water because we must live... whenever I drank water from a well, I felt like I was drinking poison...’; ‘Now, I don’t take water from the well to bathe the Bodhi tree in Anuradhapura... I use water from the natural spring instead...’; ‘Now we never use well water for water chanting... (watura maturanava)’; ‘When food is prepared to be offered to monks in the temple, they ask us not to use well water for cooking; ...now in my daily offerings (dana) to the Buddha statue at home, I don’t use well water as pān [drinking water offered to Buddhist monks]’; ‘Now we don’t use well water for cooking or drinking.’ Many informants noted significant reductions in water consumption as a consequence.

#### 4. Conclusion

The narrative unfolds against the backdrop of a transitional period within the rural communities of the NCP when access to potable water underwent significant evolution. Before the widespread introduction of RO water, these communities relied on various alternative sources for their drinking water needs: natural springs, rainwater harvesting, and locally retailed bottled water were the primary sources sustaining the populace. The shift away from traditional water sources coincided with a decline in the prevalence of CKDu. This decline was attributed, at least in part, to adopting alternative water practices, and the period before 2016 marked a pivotal phase when communities experimented with different water sources in their quest for cleaner and safer drinking water.

The emergence of RO water as a significant source of potable water in 2016 represented a watershed moment in the region’s water landscape. Its adoption signified a departure from traditional practices and a pivot towards modern filtration technology. The assimilation of RO water into daily life was facilitated by installing filtration systems within villages, making clean water more accessible. To understand the trajectory of the reduction in the incidence of CKDu in the NCP, it is imperative to contextualize it within the broader narrative of water source transitions. The community’s early efforts to embrace alternative water sources laid the groundwork for the eventual acceptance of RO water. This shift in perception, from viewing water as a natural resource to be sourced locally to a commodified product, played a crucial role in the subsequent adoption of RO water. A testimonial from a villager encapsulates the sentiment of the community regarding the transition to RO water: ‘Now we don’t have to go to the shop or spring to get our drinking water. Now drinking water - i.e., RO water - is available in the village. RO water is clean, with no odor, color, or sediments.’ This endorsement underscores the tangible benefits perceived by the community, highlighting the cleanliness and convenience associated with RO water compared to traditional sources. In sum, the journey towards mitigating CKDu incidence in the NCP of Sri Lanka is intertwined with the evolution of water-sourcing practices.

#### Declarations

**Ethics Approval and Consent to Participate:** The Ethical Committee at the Faculty of Medicine, University of Peradeniya, approved the use of verbal informed consent for interviewees due to their limited literacy or preference against reading consent documents. This consent procedure was implemented as part of a larger research project initiated in 2013, for which ethical approval was obtained from the Ethical Committee of the Faculty of Medicine, University of Peradeniya.

**Consent for Publication:** Not applicable.

**Competing Interests:** The author has no competing interests.

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**Availability of Data and Materials:** The datasets generated and/or analyzed during the current study are not publicly available due to the sensitivity of the information and the inclusion of personal data from respondents. However, they are available from the corresponding author upon reasonable request.

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**Authors’ Contributions:** Author analyzed the data and wrote the article.

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