

## Samoa's fresh waters: a need to protect its quantity and quality

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### Introduction

The aim of this section is to give an overview of the background to the main fresh water developments in Samoa from the 1980s, especially as they relate to Agriculture and Forests among Ministry of Agriculture, Forests, Fisheries and Meteorology (MAFFM) mandate. Fresh water's importance cannot be over-emphasized as in the Samoa Water Authority's (SWA) logo 'E te soifua i le Suavai - Water is life'.

Living organisms are about 70 percent water; without water there is no life as we know it. Because of water's critical importance, all persons are stakeholders and have interests in it. Aside from MAFFM interests (agricultural irrigation, livestock, even fisheries, as well as meteorology's hydrology) the Department of Lands, Surveys and Environment (DLSE) has taken the coordinating lead, with the Samoa Water Authority (SWA), Electric Power Corporation, Department of Health, and the Treasury Department, among others. Technical assistance has been received from the Food and Agriculture Organisation (FAO), World Health Organization (WHO), United Nations Environment Programme (UNEP), through the United Nations Development Programme (UNDP), and the South Pacific Regional Environment Programme (SPREP). Donor assistance is currently from the European Union, including especially Germany, Australia, New Zealand, and Japan. The DLSE draft National Water Resources Policy has recognized the coordination of these diverse (fragmented) interests as a major challenge.<sup>1</sup>

A look at the map of river systems in Upolu (Figure 1) shows what is well known that the northwestern, leeward or rainshadow areas, especially in Savaii, (Figure 2) are poorly supplied and, aside from rainfall catchment supported by Japanese and earlier UNDP assistance, largely depend on boreholes to groundwater where reticulation from distant rivers is not practical.

The critical importance of drinking water has been recognised in Samoa since at least the New Zealand administration's Land for Water Supply Purposes Ordinance 1921 with acquisition of public land in the Vaisigano watershed for the greater Apia area, although creating tensions with traditional landowners. The Watershed Protection and Management Regulations 1992 established a Committee whose Secretary is the current Director of MAFFM (the second author).

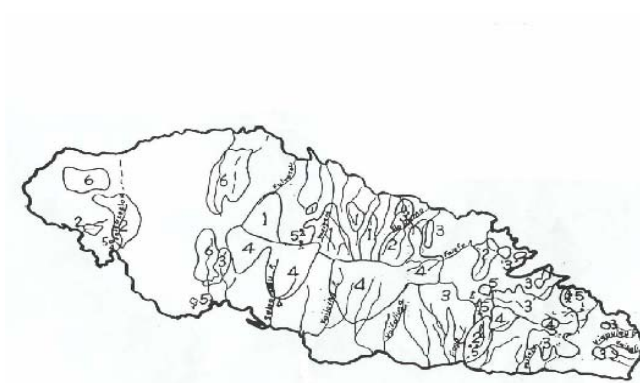
The first draft management plan was prepared for the Vaisigano watershed.<sup>2</sup> The degradation of the latter after Cyclone Val was clear.<sup>3</sup> A plan was also drafted for the Fuluasou watershed, where there were similar tensions.

Following the 1992 United Nations Conference on Environment and Development's Rio Declaration, the SPREP supported National Environment Development and Management Strategies (NEMS) for the region including Samoa. A companion State of the Environment

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Report included a section on water resources<sup>4</sup>. Deforestation was recognized as the most important problem in Samoa. A Forestry Policy was accepted by Cabinet in 1995 with water catchment protection the second priority following forest conservation<sup>5</sup>.



#### Legend

**Class 1:** Immediate action required due to high population and large investments. Streams commonly flood and deliver high sediment loads. Pressure on watershed by encroachment is high

**Class 2:** Short term investigation is required. Watersheds are possible sediment sources of areas of flooding. Possible that two catchments will be logged.

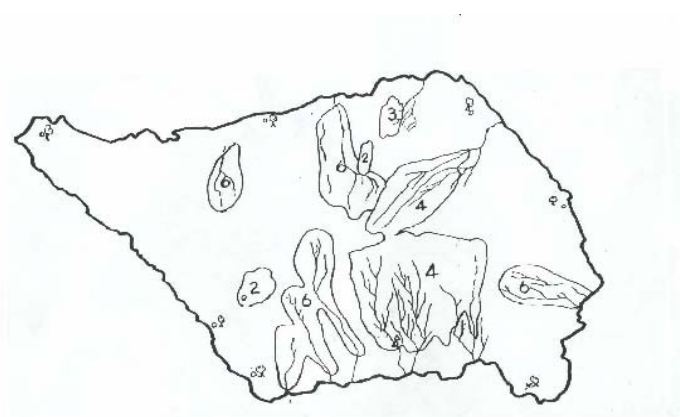
**Class 3:** Immediate term investigation required. As are water intake catchments where risk of frequent contact with surface water is high.

**Class 4:** Long term investigation required. Similar to Class 3 but because of isolation and canyon setting, frequent contact is unlikely.

**Class 5:** Sites of potential impact requiring review when project is activated.

**Class 6:** Low hazard but continuing observation needed to prevent losses.

Figure 1: Classes of watershed in Upolu



#### Legend

**Class 2:** Short term investigation is required.

Watersheds are possible sediment sources of areas of flooding. Possible that two catchments on Savaii will be logged.

**Class 3:** Immediate term investigation required. As are water intake catchments where risk of frequent contact with surface water is high.

**Class 4:** Long term investigation required. Similar to Class 3 but because of isolation and canyon setting, frequent contact is unlikely.

**Class 5:** Sites of potential impact requiring review when project is activated

**Class 6:** Low hazard but continuing observation needed to prevent losses.

Figure 2: Classes of watersheds in Savaii

The MAFFM Forestry Division Watershed Management Section's activities illustrated: 'preparation of watershed management plans, conservation plantation, watershed inventory, training and promotion of participation of different target groups in conservation of watersheds through extension education and awareness programme. The participation of watershed communities has proven to be the sustainable path for the success of the watershed management programme implemented in the Vaisigano and the Fuluasou Watersheds<sup>6</sup>. The conservation farming plot at Magiagi included contour strip cropping, hillside ditches, bench terraces, orchard crops, and forest<sup>7</sup>.

The Forestry Division's Watershed Management activities included those at Lefaga (Faleaseela) and Falelatai Districts<sup>8</sup>. Actions taken on the main recommendations of the FAO's 24<sup>th</sup> Regional Conference for Asia and the Pacific included support for 5 workshops on watershed management for Samoa<sup>9</sup>. The National Biodiversity Strategy and Action Plan

includes under the theme for ecosystems, an objective for conservation areas including actions to:

- Extend the watershed programme to all the priority areas and the smaller village based water catchment areas; and
- Develop and implement programmes for the restoration of degraded ecosystems such as watershed areas<sup>10</sup>.

The current Statement of Economic Strategy reports the German funded Water Supply Improvement Project for Apia expected to be completed in the year 2000, with the European Union's Rural Water Project for NW Upolu and Savaii commenced in the year 2000. Australian Government has an Institutional Strengthening Project for the SWA<sup>11</sup>.

The former Deputy Speaker presented a paper on how parliamentarians can contribute to the prevention of environmental degradation. Locally, through Village Fono (i.e. Council; Act 1990) they can promote village education on, firstly, preservation of forests and means of reforestation<sup>12</sup>.

### **Water quantity**

The Land Resource Planning Study included a cost benefit analysis of watershed protection involving unpriced values for the Vaisigano Pilot Watershed Management Project referring to an earlier 1983 FAO study. Benefits included: improved water quality, increased dry season flows and reduced wet season flood flows and soil erosion.<sup>13</sup> Considerable crop area was planted on unsuitable land capability classification.

Inappropriate land use contributes to problems of soil erosion, flash flooding, lowering of stream water quality and degradation of Samoa's lagoon fisheries. Such inappropriate land use could be avoided or minimized by proper land use planning, applied at three levels – national, district and village.<sup>14</sup> A NEMS draft Land Use Policy submitted in 1996<sup>15</sup> has been revised. However, while runoff and erosion from research plots has been found virtually negligible, it is reported by farmers of Magalia steep lands as more common.<sup>16</sup>

### **Water quality**

Sediments - A SWA Master Plan Study considered the major pollutants of disease, solids (sediments) and pesticides. The latter were not found in 11 water sources, largely boreholes, from Savaii as well as Upolu.<sup>17</sup> The SWA also coordinated a Working Group which drafted drinking-water standards including microbiological, chemical (inorganic, organic, disinfectants, pesticides) and aesthetic (e.g. turbidity/sediments).<sup>18</sup>

A SPREP regional study looked at sediments transported via rivers to the ocean and their role as pollutants, including Samoa.<sup>19</sup> A SPREP Regional workshop (including the senior author and Forestry Division participants) was conducted in Samoa on Protection of the Marine Environment from Land-Based Activities in the Pacific Islands.<sup>20</sup> Samoa's International Waters (IW) also integrates the ocean with rivers, lakes, groundwater systems, wetlands and coastal zones.<sup>21</sup> The UNDP advertised for a Divisional Assistant for the Strategic Action Programme for IW of the Pacific Islands Region.<sup>22</sup>

A Public Works Department Apia sewerage project looked at contamination of freshwater discharge.<sup>23</sup> Localized problems in Samoa were noted to include industrial wastes affecting water and coastal pollution.<sup>24</sup>

Source	No. of samples	Aldine	DDT	Endo-sulfa	Heptachlor	Lindale
Fresh water	17	0.06(0.07)	0.015(0.1)	0.01 (0.23)	0? (0.23)	0.11 (0.4)
Soil	1	0.01	0	0	0	0.07
Marine Fish	5	0	0	N.A	0.14 (0.23)	0.14 (0.23)
Human Fat	14	N.A	8.45(16.9)*	N.A	N.A	N.A
Eggs	8	0.08 (0.36)	0.96 (4.8)*	N.A	0.06 (0.17)*	0.4 (0.54)*
Chinese cabbage	2	0	0.02 (0.02)	0	0.01 (0.01)	0.05 (0.08)*
Taro	7	0.01(0.02)	0	0	0	0.07 (0.1)*

Table 1: Results of selected\*\*1980 pesticides residue analyses, Upolu, Samoa:average (highest) value obtained (mg/kg). Source: Fryauff (1982). \*Marked on analyses (by unknown person). \*\* Others reported: Human & cow's milk; beef; banana; citrus; cucumber; green pepper; guava; onion; and tomato. No organo-phosphorus pesticide residue detected.

Pollutants	Wharf (cm*)	Mulinuu reef (Np)	Vaiusu mangrove (Gt)	Vaitele mangrove (Gt)
DDT+DDD	41.6	6.3	16.5	20.5
Dieldrin	0.34	0.58	0.27	0.19
Lindane	-	0.55	-	-
Chlordane	0.09	-	0.06	-
PCH	-	0.21	-	-
PCBs (total)	1.06	0.12	0.52	0.24
PNA/PAH** (total)	90.9	0.90	18.9	0.76
Metals:				
Arsenic	0.08	0.42	0.20	0.11
Copper	178***	2.7	0.8	0.7
Lead	0.019	0.006	0.033	0.031
Mercury	0.030	<0.002	<0.002	0.008
Tin	0.19	0.13	0.23	0.45
Zinc	19	9.4	5.9	4.4

Table 2: Persistent organic pollutants (POPs; ng/g wet mass) and heavy metals (mg/kg) in shellfish in the greater Apia area, Samoa. Source: Govt. of W. Samoa, PWD & Kreditanstalt fur Wiederaufbau (1993). \*Cm=Crassostrea mordax rock oyster; Np=Nerita polita; Gt=Gafarrarium tumidum tunane. \*\* Poly-Nuclear Aromatic Hydrocarbons (from burning). \*\*\* possibly emetic level.

Pesticides - Fresh water samples taken in 1980 were found to have residues of five Persistent Organic Pollutants (POPs) which were shown to bio-accumulate in crops and in second-order consuming chicken eggs, etc and especially third-order human fat (Table 1).<sup>25</sup> The Agriculture Store Corporation formerly sold (at least) three POPs, including chlordane that was not analyzed.<sup>26</sup> The latter, although banned by Samoa from import under the interim Rotterdam Convention for Prior Informed Consent for Hazardous Chemicals/ Pesticides, was reported as used for termite control in Samoa, until recently.<sup>27</sup>

The senior author gave a presentation with representatives of Departments of Health, Lands, Surveys and Environment of Samoa's potentially toxic chemicals management at a regional meeting, including a summary of the PWD (ibid) report of residues of POPs and metals in shellfish and marine sediments (Table 2).<sup>28</sup> The SPREP Action Plan 2001-2004 was noted as

not directly involved in Control and Management of Chemicals and Pesticides, while further phases of a POPs inventory of the region awaits their disposal<sup>29</sup>. Samoa sees SPREP's future role as including land use management in relation to use of chemicals/ pesticides.<sup>30</sup>

### **Overview on land-based pollutant sources and activities affecting the marine, coastal and freshwater environment in the Pacific Islands region**

Following submission of the abstract, the UNEP with SPREP's above report prepared following a meeting in Apia in October 1999, in which the senior author participated with another MAFFM colleague from the Forestry Division, was received. Although a regional overview, much also apply to Samoa, for which specific details are given. The relative amounts as suspended solids, etc. in Samoa are given in Table 3.<sup>31</sup> Clearly, as well as the latter, the hazard of pathogens and pollutant chemicals/ pesticides must also be considered (Table 4).<sup>32</sup> The main conclusions and recommendations from the report were: Overarching threats from land-based sources of pollution include physical, Ecological and hydrological modification of critical habitats as well as Pollution.

<b>Pollutants</b>	<b>Suspended Solids (kt/yr.)</b>	<b>BOD* (kt/yr.)</b>	<b>N* (kt/yr.)</b>	<b>P* (kt/yr.)</b>
River sediments	7,100-8,700		67	21
Domestic waste water loadings	584	1,170	740	83
Solid waste generation	59			
Industrial pollutants	10	64		

Table 3: Suspended solids etc. produced by various pollutants in Samoa. Source: UNEP with SPREP (2000). \* BOD = Biological Oxygen Demand; N=Nitrogen; P=Phosphorous

<b>Waste</b>	<b>Sewage</b>	<b>Solid Waste</b>	<b>Agriculture</b>	<b>Industrial</b>	<b>Physical alteration / habitat destruction</b>
Sewage	X		+		
Nutrients	X	X	X	X	
Sediments	X		X	X	X
Litter		X			
POPs		X	X	X	
Heavy metals		X			

Table 4: Priority activity areas for rapid intervention in the Pacific and Samoa, Source: UNEP with SPREP (2000). + Believed by the authors as also a source of animal sewage wastes, per recommended removal of cattle from Vaisigano watershed.

This and previous regional consultations have considered prioritisation of these threats as inappropriate due to linkages among threats. The recognition of the need for integrated management is essential both on technical and on practical resource considerations. Integrated management is necessitated by the linkages, and the limited resources of the individual countries and the region as a whole do not allow disconnected management programmes.

Sewage, sedimentation, and agricultural activities were identified as primary threats to critical species and habitats as well as non-living resources. The root causes of these threats included, but were not limited to: issues of policy; regulation and enforcement; technical capacity; data gaps; inadequate infrastructure; economic valuation of the resources; land tenure; resource pricing; loss of traditional management systems; development pressures; lack of community awareness and education; lack of community involvement; lack of planning; and other management issues.

The ultimate root cause of the imminent threats was identified as deficiencies in management, which are grouped in terms of governance and understanding. Areas for priority action to address land-based activities that have been identified through this overview are consistent with those of the International Waters Strategic Action Plan. These priority activity areas for rapid intervention are found in Table 4.

These priorities for action must be addressed through resolution of the root causes. Strategies and measures for addressing the management of priority action and addressing root causes of the threats to the marine environment have been identified. These strategies are grouped into five categories: Management; Capacity building; Awareness/education; Research/information for decision-making; and Investment.

The region has identified domestic sewage-discharges, solid waste from domestic, industrial, and construction activities, fertiliser use, sediments, and increasingly toxic wastes from industrial, agricultural, and domestic sources as the significant land-based sources. Nevertheless, the relatively small quantities of hazardous and toxic materials (e.g. persistent organic pollutants and heavy metals are of critical concern based on known and potential effects on the...environment'.<sup>33</sup>

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<sup>31</sup> UNEP with SPREP (ibid).

Although much larger in area, Savaii's drainage area is less than Upolu, as also the sediment loading.

Solid waste generation assumed 1 kg/ person-day of relatively organic-rich wastes, which awaits DLSE report of recent surveys (see Tauleleausumai L.M., this proceedings).

<sup>32</sup> UNEP with SPREP (ibid)

<sup>33</sup> UNEP with SPREP (ibid)