

Aborigines and Uranium: Monitoring the Health Hazards

Colin Tatz, Alan Cass, John Condon and George Tippet

AIATSIS Research Discussion Paper Number 20

December 2006

AIATSIS Research Discussion Paper 20

First published in 2006 by the
Research Section

Australian Institute of Aboriginal and Torres Strait Islander Studies
GPO Box 553 Canberra 2601

Edited by Colin Tatz and Graeme K Ward

AIATSIS Research publications co-ordinator: Graeme K Ward

The views expressed in this publication are those of the authors and not necessarily those of the Australian Institute of Aboriginal and Torres Strait Islander Studies.

Copyright ©AIATSIS, Colin Tatz, Alan Cass, John Condon, George Tippett.
Apart from any fair dealing for the purpose of private study, research, criticism or review, as permitted under the Copyright Act, no part of this publication may be reproduced without the written permission of the publisher and the authors.

NATIONAL LIBRARY OF AUSTRALIA CATALOGUING-IN-PUBLICATION DATA:

Aborigines and uranium : monitoring the health hazards.

Bibliography.

ISBN 0 85575 539 3.

1. Uranium mines and mining - Health aspects - Northern Territory. 2. Radiation - Health aspects - Northern Territory. 3. Aboriginal Australians - Health and hygiene - Northern Territory. I. Tatz, Colin. II. Australian Institute of Aboriginal and Torres Strait Islander Studies. (Series : Research discussion paper (Australian Institute of Aboriginal and Torres Strait Islander Studies); 20).

622.34932099429



Research Program
Australian Institute of Aboriginal and Torres Strait Islander Studies

EDITORS' NOTE

This discussion paper is, with modification to the preliminary materials, almost identical to a formal submission from the Council of the Australian Institute of Aboriginal and Torres Strait Islander Studies to the Review of Uranium Mining, Processing and Nuclear Energy. A copy of the letter of transmission signed by the Chair of Council, Professor Mick Dodson, follows:

Uranium Mining, Processing and Nuclear Energy Review Secretariat
C/- Department of Prime Minister and Cabinet
3-5 National Circuit
Barton ACT 2600

Dear Sir/Madam,

Please find enclosed a submission from the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) to the Uranium Mining, Processing and Nuclear Energy Review Taskforce.

The submission was prepared on behalf of the AIATSIS Council by Professor Colin Tatz, Dr Alan Cass, Dr John Condon, and Dr George Tippett. Professor Tatz was Chairperson of a previous research project conducted by AIATSIS and reported in a consolidated volume *Aborigines and Uranium*, 1984.

The AIATSIS submission relates to the health and safety issues for communities living adjacent to uranium mining and milling operations. Specifically, the submission identifies a significant overall increase in the incidence of cancer among people in the Kakadu region which is ninety percent greater than would be expected. While not identifying a definitive cause for this increased incidence, our contention is that there is an urgent requirement for ongoing monitoring of health protection and prevention measures for communities living adjacent to uranium mining and milling operations.

We trust that this submission, and the urgent issues identified, will be given full consideration by the Taskforce. AIATSIS and the authors are available to provide any further information about this research that may be required.

We would appreciate formal acknowledgment of receipt of this submission at your earliest convenience.

Yours sincerely,

Professor Mick Dodson
Chair
12 December 2006

ABORIGINES AND URANIUM: MONITORING THE HEALTH HAZARDS

Colin Tatz, Alan Cass, John Condon and George Tippet

CONTENTS

EDITORS' NOTE and LETTER OF TRANSMISSION	iii
ABSTRACT	vii
I. RADIATION AND HUMAN HEALTH	1
II. IN SEARCH OF SURENESS	4
III. THE FOX DECISION	5
IV. THE FIRST MONITORING EXERCISE	6
V. SPILLAGES AND SILENCES	10
VI. A DUTY OF CARE	15
VII. THE 2005–2006 EXPLORATION	16
(1) Potential data sources	16
(2) The Aboriginal population of the Kakadu Region	17
(3) Cancer occurrence in the Kakadu population	18
(4) Findings	19
(5) Congenital malformations	21
(6) Stillbirths	21
(7) Discussion	21
VIII. SOCIAL IMPACT ASSESSMENT	22
IX. MONITORING MINING HAZARDS: AN INTEGRATED MODEL	23
(1) Promotion of health and well-being	24
(2) Preventive health services	25
(3) Personal curative services	26
(4) Personal database collections	26
(5) Personal rehabilitative services	26
(6) Environmental health services	27
X. CONCLUSION	27
ACKNOWLEDGMENTS	29
APPENDIX: INTERVIEWS	29
REFERENCES	30
THE AUTHORS	33

Abbreviations

ABS	Australian Bureau of Statistics
AIAS	Australian Institute of Aboriginal Studies
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies (formerly AIAS)
AIHW	Australian Institute of Health and Welfare
APC	Aboriginal Project Committee
BCRCI	British Columbia Royal Commission of Inquiry
BEIR	Biological Effects of Ionizing Radiation
BTP	Best Technology Practice
CD	Collector District
CMS	Church Missionary Society
ERA	Energy Resources of Australia (Ranger Mine)
ERISS	Environmental Research Institute of the Supervising Scientist
IAIA	International Association for Social Impact Assessment
KRSIS	Kakadu Region Social Impact Study
NLC	Northern Land Council
NT	Northern Territory
NTEC	Northern Territory Environment Centre
OSS	Office of the Supervising Scientist
SIA	Social Impact Assessment
SLA	Statistical Local Area
UPSC	Uranium [Impact] Project Steering Committee
WBP	World's Best Practice

Note to on-line readers

We have provided hypertext links to most of the original articles cited, or quoted from, in this paper. By clicking on the footnotes at the bottom of each page, readers can gain access to the original material.

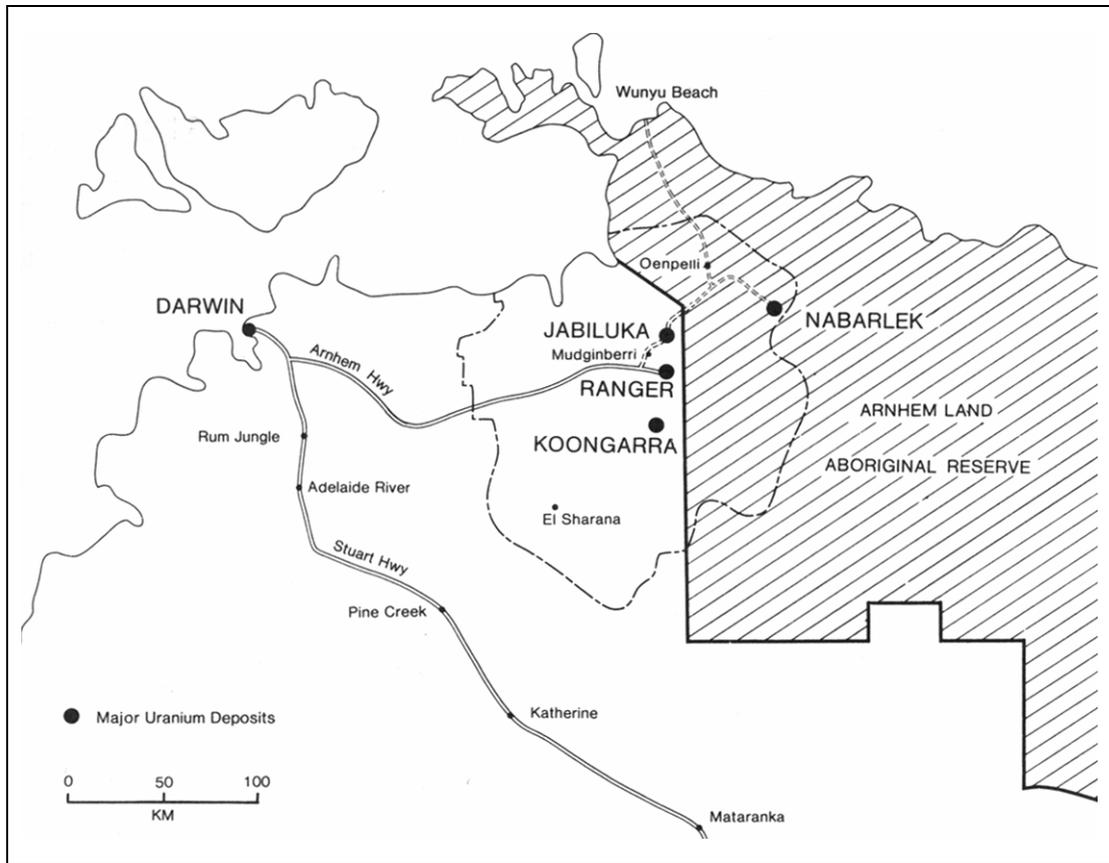


Figure 1. The Kakadu Region in Relation to Darwin (after Tatz 1982:121)

ABSTRACT

The Uranium Mining, Processing and Nuclear Energy Review Draft Report deals with Health and Safety issues (Chapter 6) and with Environmental Impacts (Chapter 7). At p.63, the report states that ‘there are legacy problems associated with the Nuclear industry’, and that ‘protecting the people must be a high priority’. The report notes that ‘there may be incidents at the mines that give rise to non-routine radiation exposure’ and that at Ranger ‘incidents occurred in 1983 and 2004’ (p.71). In this context, the Review raises the complex question of how risk is perceived, and how the public and the experts at times have different perceptions of risk.

This paper specifically addresses several of the issues that come within the Review’s terms of reference. It may differ from most of the submissions and consultations to date in that it deals with essentially one critical case study of a definable Aboriginal community living in the vicinity of uranium mining and milling. But it also offers a positive model for the ongoing monitoring of health protection and prevention measures that could be adopted for uranium mining operations elsewhere in Australia.

Uranium has been mined and milled in a Northern Territory Aboriginal domain — the Kakadu Region — for the past three decades, ostensibly under ‘strictly controlled conditions’. Have uranium operations adversely affected Aboriginal health in the Region?

High doses of radiation are known to cause cancers, foetal damage, congenital malformations and even to retard cognitive development. We know less about the effects of low doses, but any community-protection program must assume some degree of health risk. Radiation can enter the body by ingestion of local food and water, by inhaling radioactive gases and airborne dust, and by irradiation from external sources.

Since 1981, three years after mining began, at least 120 ‘mishaps’ and ‘occurrences’ — leakages, spillages of contaminated water, and breaches of regulations — have occurred. The Office of the Supervising Scientist has consistently claimed no harm to either the environment or human health — a claim difficult to substantiate. Since completion of the AIATSIS social impact monitoring report in 1984, there has been no monitoring of the social and physical impact on Aboriginal health and well-being, and no agency has specifically investigated the impacts on Aboriginal health.

Exploratory research undertaken in 2005 and 2006 has found a significant overall increase in the incidence of cancer among Aboriginal people in the Kakadu region — some ninety per cent greater than would be expected. We could not determine possible effects on maternal and child health because data on congenital malformations and stillbirths were not available.

Existing data sets are not adequate to identify a definitive cause for the increased cancer incidence. There could be reasons for the high cancer rates other than proximity to uranium mining and milling. However, in the light of this lack of knowledge, we submit that there is an urgent need for continued, comprehensive monitoring of health wherever uranium mining occurs, and for at least twenty years after mines cease operation.

Our suggested model for ongoing monitoring would cost a few hundred thousand dollars per year. The proposal is neither radical nor expensive. It makes better sense — in human, political, economic and, eventually, legal terms — to monitor and to control potential hazards than to treat the toxic effects of radiation exposure.

I. RADIATION AND HUMAN HEALTH

The harmful effects of ionizing radiation on human health are well-established.¹ Chromosomal abnormalities, birth defects and deaths from radiation-induced cancers, among other consequences, tend to be measured according to a Hiroshima-Nagasaki-Chernobyl 'yardstick'.² Even with regard to these large-scale nuclear catastrophes, some observers have suggested that adverse effects on population health in surrounding areas have been overstated.

Taking the Chernobyl nuclear reactor meltdown as an example, approximately 1000 emergency workers and on-site personnel received the highest radiation doses, acute radiation sickness was confirmed in 134 persons significantly exposed to radiation during and in the immediate aftermath of the accident, and twenty-eight died from the immediate consequences of radiation exposure.³ By 2002, more than 4000 thyroid cancers had been confirmed among those who were children at the time of the disaster, and whose radiation exposure was attributed to drinking milk with high levels of radioactive iodine.⁴ With regard to the health of the surrounding population, however, an international team of scientists contended that:⁵

Apart from the dramatic increase in thyroid cancer incidence among those exposed at a young age, there is no clearly demonstrated increase in the incidence of solid cancers or leukaemia due to radiation in the most affected populations. There was, however, an increase in psychological problems among the affected population, compounded by insufficient communication about radiation effects.

Other studies have reported an increase in the risk of childhood leukaemias.⁶ According to America's authoritative National Research Council report (BEIR VII), 'scientists have long known that in addition to cancer, ionizing radiation in high doses causes mental retardation in the children of mothers exposed to radiation during pregnancy'.⁷ Greater scientific uncertainty persists regarding the health effects of low-dose radiation, such as that which might arise from uranium mining and milling operations.

In certain scientific circles in Australia, uranium mining and milling seem to be regarded with an uncritical faith. The general thrust is that provided there is strong regulation and a strict adherence to guidelines, there should be no hazards and no deleterious outcomes to those who are either involved in the mining arena or living in close proximity to mining operations. Breakdowns, contaminated water spillages and accidents are 'mistakes' or 'occurrences' — which have been said to pose no danger to

¹ ARPANSA 2005 [ARPANSA](#).

² Meeting Report Low-Dose Radiation Risk Assessment 2006.

³ Gottlober et al 2001 [Gottlober](#).

⁴ Chernobyl Forum 2006 [Chernobyl](#).

⁵ Chernobyl Forum 2006.

⁶ Noschenko et al 2003 [Noschenko](#).

⁷ National Research Council 2005:1 [BEIR VII](#).

human health. In short, Best Technical Practice (BTP) or World's Best Practice (WBP) suggests that the uranium industry is highly-regulated, well-controlled and safe.

Why then have we been troubled enough to propose a comprehensive and ongoing form of monitoring for potential adverse effects of uranium mining and milling?

One answer lies in the legislative approach towards protecting individuals, their children and the community from the possible harmful effects of radiation. Everyone is exposed to radiation from natural 'background' sources and from human activities. However, some human activities, including uranium mining and milling, potentially increase the overall exposure to radiation.⁸

The nationally defined dose limits for ionizing radiation indicate that members of the public should receive an effective radiation dose of no more than 1mSv in a year.⁹ However, dose limits cannot be used to determine a demarcation between the 'safe' and the 'unsafe' with regard to certain harmful effects on human health — including damage to cells which can lead to the development of cancer many years later.¹⁰ Australian community radiation protection standards are based on the assumption that an increase in a person's exposure to ionizing radiation, even at low doses, increases the risk of harm to that person's health.¹¹ Although lower doses of radiation are associated with lower health risks,¹² one of the basic assumptions in this submission is that there is no level of excess radiation exposure which can be claimed to be completely safe.

A second answer is provided by the scientific literature exploring the health of workers in the nuclear industry. Although the effects of continuing, low-dose radiation on health are clearly contested, a sufficient body of evidence has accumulated to warrant grounds for concern. Through airborne exposure to radon daughter isotopes, occupational exposure to uranium is a well-recognised risk factor for lung cancer.¹³ Although some research suggests that the risk for cancers other than lung cancer might not be increased,¹⁴ the recent and authoritative report on radiation risk of the National Research Council of the United States National Academy of Sciences, the BEIR VII Report, concluded that every exposure to radiation produces a corresponding increase in cancer risk, including an increased risk for non-lung cancers.¹⁵ This increased risk for cancer is believed to arise through radiation causing damage to human DNA. A number of studies have reported increased rates of chromosomal damage among nuclear industry workers.¹⁶ Other studies, however, have found no increase.¹⁷

What do we know of the health effects for communities in the vicinity of uranium mining and milling or other nuclear industry facilities? In communities near uranium

⁸ ARPANSA 2002:r-5 [ARPANSA2002](#).

⁹ ARPANSA 2002:r-25 [ARPANSA2002](#).

¹⁰ ARPANSA 2002:r-6 [ARPANSA2002](#).

¹¹ ARPANSA 2002:r-7 [ARPANSA2002](#).

¹² ARPANSA 2005:48.

¹³ Roscoe et al 1989 [Roscoe](#); Tomasek et al 1994; [Tomasek](#); Wesch et al 1999 [Wesch](#).

¹⁴ Tomasek et al 1993 [Tomasek2](#); Boice 2006 [Boice](#); Darby 1995 [Darby](#).

¹⁵ National Research Council of the National Academies 2005 [BEIR](#).

¹⁶ Livingston 2006 [Livingston](#); Zaire 1997 [Zaire](#).

¹⁷ Lloyd 2001 [Lloyd](#).

sites, radiation exposure can enter the body through ingestion of water and food sourced from the local environment, inhalation of radioactive gases and airborne dust, and from external sources of radioactivity.¹⁸ The Environmental Research Institute of the Supervising Scientist (ERISS) has described the challenges of mining in a tropical area. The Kakadu Region has pronounced wet and dry seasons: ‘high rainfall during the wet season often results in the need to release low-level contaminate run-off stored in on-site water-bodies into Magela Creek’, which feeds the surrounding Kakadu wetlands.¹⁹ The environmental monitoring program focuses on water quality guidelines, monitoring radiation accumulation in local aquatic flora and fauna, and modelling the *hypothetical* contribution to human radiation dose accumulation.²⁰ There is no evidence of any co-ordinated approach to monitoring human radiation exposure or the *actual* health of communities in the Kakadu Region.

During the late 1940s, 50s and 60s, uranium was mined at multiple sites across Navajo lands in Arizona and New Mexico. At the very least, Navajo people were poorly informed regarding the potential harmful effects of uranium mining²¹ and large-scale ‘accidents’ have been reported, such as the July 1979 bursting of the tailings dam at Church Rock, New Mexico, which released almost 355.8 million litres (94 million US gallons) of contaminated liquids and 998 metric tons (1100 US tons) of radioactive solids into the Puerco River.²² Late onset cancers among the Diné-Navajo people, especially among the men who were recruited to low-paid and hazardous mining jobs,²³ left what the native people still call ‘a legacy of tears’. It was their experience that prompted an emphasis on health impacts in the first social impact monitoring exercise in the Northern Territory, discussed in Section IV below.

Many observers have argued that particular attention should be given to the impact of uranium mining on indigenous populations²⁴ and that more emphasis should be placed upon using validated biomarkers to monitor health risk among potentially exposed populations.²⁵ Although evidence regarding the effect on the health of local residents remains contested, such as whether cancer rates are increased²⁶ or unchanged²⁷, it would be unreasonable to conclude, based on a review of the evidence, that uranium mining and milling have no adverse effects on the health of local populations. In this setting, we argue that we should implement a system for the ongoing, comprehensive monitoring of human health.

¹⁸ van Dam 2002 [van Dam](#).

¹⁹ van Dam 2002 [van Dam](#).

²⁰ van Dam 2002 [van Dam](#).

²¹ Brugge 2002 [Brugge](#).

²² Graf 1990 [Graf](#); Tatz 1982:120.

²³ Brugge 2002.

²⁴ Brugge 2005.

²⁵ Au et al 1998 [Au](#).

²⁶ Lopez-Albente 2001 [Lopez-Albente](#).

²⁷ Boice 2003 [Boice](#).

II. IN SEARCH OF SURENESS

In many of life's concerns — such as our personal health, our physical safety, our environment — there is no language of certainty. For example, despite the body of evidence establishing that smoking is a health hazard, there is still emotional debate, denial from the tobacco industry and spin-doctoring from pubs, clubs and restaurants regarding 'smokers rights'. The issue of uranium mining and milling, and nuclear energy more broadly, has inspired a similarly fierce debate.

In June 2006, John Howard announced the establishment of a taskforce 'to undertake an objective, scientific and comprehensive review' of uranium mining and processing and the contribution of nuclear power in the long term.²⁸ 'Objective' conveys the message (and the belief) that the human element will be eliminated from the review, and that those involved are detached and impersonal. The word 'scientific' in this context implies that the study will be accurate, precise, exact, sure — and beyond dispute. 'Comprehensive' suggests that the review will cover the breadth of relevant evidence regarding the effects — both positive and negative — of uranium mining and processing, in order to make recommendations regarding the appropriate place of a uranium industry and possibly of nuclear power in Australia. It is partly because the Review's draft report does not appear to comprehensively address the Aboriginal issues that we have made this submission.

What underpins this paper is the truth that much of science is not accurate, precise or unassailable. Stephen Jay Gould, among the acclaimed minds of science in the twentieth century, defined the 'problem' with clarity:²⁹

... the usual mythology about scientific practice — [is] that facts are 'hard' and primary and that scientific understanding increases by patient collection and sifting of these objective bits of pure information ... Instead ... science is a human activity, motivated by hope, cultural prejudice and the pursuit of glory, yet stumbling in its erratic path toward a better understanding of nature.

It must be stated clearly that the authors and AIATSIS as a body are not advocates *for* or *against* uranium mining or nuclear energy. But we are not impartial about the potential adverse effects of uranium mining in an Aboriginal environment. Consistent with Australian national approaches to community protection, we believe that radiation from the products of uranium decay is hazardous to living cells. We suggest that *it makes better sense to monitor, and thereby try to control, the hazard, rather than to attempt to cure people who might fall victim to radiation toxicity.*

Some in government and in the mining industry emphasise a 'scientific' approach to monitoring, with 'hard-edged' quantification of impact factors. Some have suggested

²⁸ Howard 2006 [Howard](#). The Taskforce members: Dr Ziggy Switkowski, former chief executive of Telstra Corporation, chairman; Professor George Dracoulis, Nuclear Physics, Australian National University; Dr Arthur Johnston, former Supervising Scientist, Northern Territory; Professor Warwick McKibbin, Economics, Australian National University; Mr Martin Thomas, chairman, Dulhenty Power Ltd.; Professor Peter Johnston, Physics, RMIT, Melbourne.

²⁹ Gould 1982:115–116.

comparing events in the Kakadu ‘uranium province’ with another non-mining Aboriginal community as a ‘control’. In such an approach, they see no room or relevance for ethical, historical, political, social or cultural factors. Selective data, particularly in statistical form, become the *sole* consideration. It should not be necessary, but it still needs to be made plain that the bringing together of Aborigines, uranium and a national park is not something that can be easily weighed, measured, assessed, diagnosed and prescribed for.

This paper is a proposal for a model to monitor and minimise impacts on the health of Aboriginal persons who work in, or live alongside, uranium mining and milling. The model brings together some scientific, some purely medical, and many human or societal markers. A brief history of monitoring, of both the ‘hard’ and ‘softer’ variety, is necessary. Any new model must have *context* if it is to have any meaning and value for those who might make use of it. To suggest a model *in vacuo* would be to disregard all that has gone before and all that has made the present situation what it is. To ignore that history would be, in our view, unintelligent and unprofessional. (Many people in the mining industry and in bureaucracies today would be unaware of the events of the late 1970s and early 1980s, all of which have direct bearing on the Aboriginal–mining relationship today. We note that the Institute’s 1984 consolidated report, *Aborigines and Uranium*, was not cited in the Review’s draft report list of references.)

III. THE FOX DECISION

In the 1970s, it became clear that the Australian nation wanted to enjoy its natural wonders, like Kakadu, and to make a gift of that place to the world’s heritage. It also wanted, or needed, to exploit Kakadu’s unexpected rich crop of uranium ore. It also felt the need to make some amends for the depredations on Aboriginal society. These three elements came together in the Alligator Rivers Region of the Northern Territory. Each part of this triad had both powerful advocacy and strong opposition. The question was: how best to integrate these often conflicting interests? It remains a pertinent question thirty years later.

The 1977 Fox Report — formally entitled *Ranger Uranium Environmental Inquiry, Second Report* — was the impetus and ultimately the legitimating force behind mining that mineral in the Northern Territory.³⁰ Justice R.W. Fox and his two commissioners listened to strenuous Aboriginal efforts to stop any such mining, but in the end formed ‘the conclusion that their opposition should not be allowed to prevail’.³¹

Nevertheless, Fox was anxious about mining. His Chapter 13 — ‘Impacts on Aboriginal Society’ — included concerns about Aboriginal employment, morale, educational and vocational opportunities, health (including alcohol devastation), and racial tensions and conflicts. Much was said about environmental research, the need for standards, controls, monitoring and supervision; but all of this was focused on the physical rather than the social environment.

³⁰ Fox et al 1997 [Fox](#).

³¹ AIAS 1984; [Maddock 1984](#).

In August 1977, following Fox, the federal government announced the decision to mine uranium ‘under strictly controlled conditions’. The Minister for Aboriginal Affairs was to have responsibility for ‘oversight of the impact of development on the Aboriginal population’, with a ‘continuing obligation to watch the impact ...’. In the ensuing months, pressure built for social impact monitoring, mainly from the Northern Land Council (NLC). That Aboriginal body had several statutory obligations in relation to mining, and had special responsibilities to Aborigines as a signatory to the two major mining agreements, Narbalek and Ranger. The [then] federal Department of Aboriginal Affairs urged monitoring; it foresaw the Chapter 13 problems and insisted on an independent knowledge resource.

The Office of the Supervising Scientist (OSS), an agency whose establishment Fox had recommended (and which was established by law in 1978), seemed the logical choice. It quickly became clear that that Office saw the *physical* environment as its sole concern — the aspect which was easier to quantify and measure. This led the Minister for Aboriginal Affairs, Ian Viner, to propose *social* impact monitoring by the statutory body then known as the Australian Institute of Aboriginal Studies (AIAS, later AIATSIS) in March 1978:³²

I consider it important that the research program be commenced before substantial work on the uranium project begins. The research program is intended to establish base-line data on the social environment. I would then envisage a continuing research program to provide up-dated information and thus to monitor and report changes as they occur. You might refer to part 13 of the second report of the Ranger Uranium Environmental Inquiry which indicates what is needed in general form.

In October that year, the AIAS Council accepted the commission and appointed a Uranium Impact Project Steering Committee (UPSC) to study and report on this more subjective, more difficult-to-measure impact of uranium mining — initially for five years. The committee would be responsible to Council, Council in turn to the Minister, and he in turn to federal cabinet.

No such division between the physical and human environments should ever have been made. (As we show in Section IX below, there is neither professional nor common sense in divorcing the biophysical and social impacts of any development project.) A permanent, well-resourced and fully-staffed scientific unit, clearly dedicated to seeing that mining worked ‘properly’ under the rules, was always going to overshadow, even overwhelm, a temporary project dedicated to protecting Aboriginal interests.

IV. THE FIRST MONITORING EXERCISE

The UPSC composition is of interest.³³ It was considered by some to be anti-uranium, with Dr H.C. (Nugget) Coombs’s presence cited as evidence of such a stance. Others lamented what they perceived as its pro-uranium position, with conservative

³² Letter from the Hon. Ian Viner to Dr Peter Ucko, AIAS Principal, 23 March 1978.

³³ Emeritus Professor Ronald Berndt, Isaiah Burranal, Ken Colbung MBE, Dr H.C. Coombs, Dr L.R. Hiatt, Professor Max Kamien, Nathanael Maralngurra, Professor D.J. Mulvaney CMG, Jacob Nayinggul, Professor Colin Tatz (chairman), Dr Peter Ucko, Dr J.R. von Sturmer (project director), the Hon. W.C. Wentworth, Eric Willmot AM.

parliamentarian W.C. (Bill) Wentworth allegedly espousing that viewpoint. Three Aboriginal traditional elders and two leading Aboriginal intellectuals were on the committee; other eminent persons were the late Professor Ronald Berndt, Professor John Mulvaney, Professor Max Kamien, Dr Lester Hiatt and Dr Peter Ucko. There was a [commissioned] bias: to be mitigators and ameliorators in a situation where something was believed to be either harmful or potentially so. This was never intended as a cold and impartial exercise — if such were ever possible — but one based on a care and concern for the Aboriginal peoples whose domain and public were being impinged upon by an industrialisation exercise they had fought hard to prevent.

The UPSC could find no precedents for guidance; very little had been published on monitoring of this kind. It was unaware then of some protocols which had been established in diverse projects in New Zealand, in Banff in Canada, in mining development in Wisconsin and as a result of the politically-charged event that came to be known as the James Bay hydro-electric project in Canada. Several *post hoc* and *post mortem* accounts were known, but none that had started monitoring *before* a development began operating and which was also intended as a *continuing* exercise.

C.P. Wolf, a pioneer of methodology in this field of assessment, had characterised social impact as having four stages: ‘profiling’, that is, determining the existing situation; ‘projecting’, determining how the situation is likely to change with and without a given project; ‘assessing’, determining the relative magnitude and significance of the changes; and ‘evaluation’, that is, monitoring the changes by describing, explaining, informing and recommending. These became the UPSC’s general principles and guidelines.

The project team collected baseline data on the history of the Region: it undertook a census of the Aboriginal people; assembled the laws relevant to Aborigines from 1900 onwards; summarised the administration of those laws and the political philosophies on race that adversely affected the local residents; compiled food directories and details of art forms; elicited and recorded film and photographic records; assessed the state of local language and the acquisition of English; collected oral histories; and kept diaries of day-to-day events.

The UPSC examined such impact factors as the provision, distribution and use of pre-mining payments and of royalties; the employment of Aborigines in the mining industry; the nature and effectiveness of consultations with Aboriginal communities; the effects on community health profiles — then, and as mining continued; educational facilities and Aboriginal attitudes thereto; the outstation movement and its growth; housing and accommodation; and an analysis of whether governmental, mining and Aboriginal policy expectations had materialised and if not, why not?

There was a third dimension to the monitoring — looking at specific issues arising from Fox’s concerns about mining and its *sequelae*, especially for the residents of adjacent Oenpelli, the former Church Missionary Society (CMS) mission and the largest Aboriginal population centre in the Kakadu Region; the continued existence in the Region of a national park which was intended as a ‘buffer’ zone between the people and the mining project; the abiding question of Aborigines’ use of alcohol and the likelihood of a worsening problem once miners came into their environment; the question of permits for Whites to enter Aboriginal land; the mining company’s use of roads in Aboriginal-held land; the existence of a new White township of possibly 3000 persons in close proximity to Aboriginal peoples; and the changes in Aboriginal criminal conviction patterns both before and after the advent of mining.

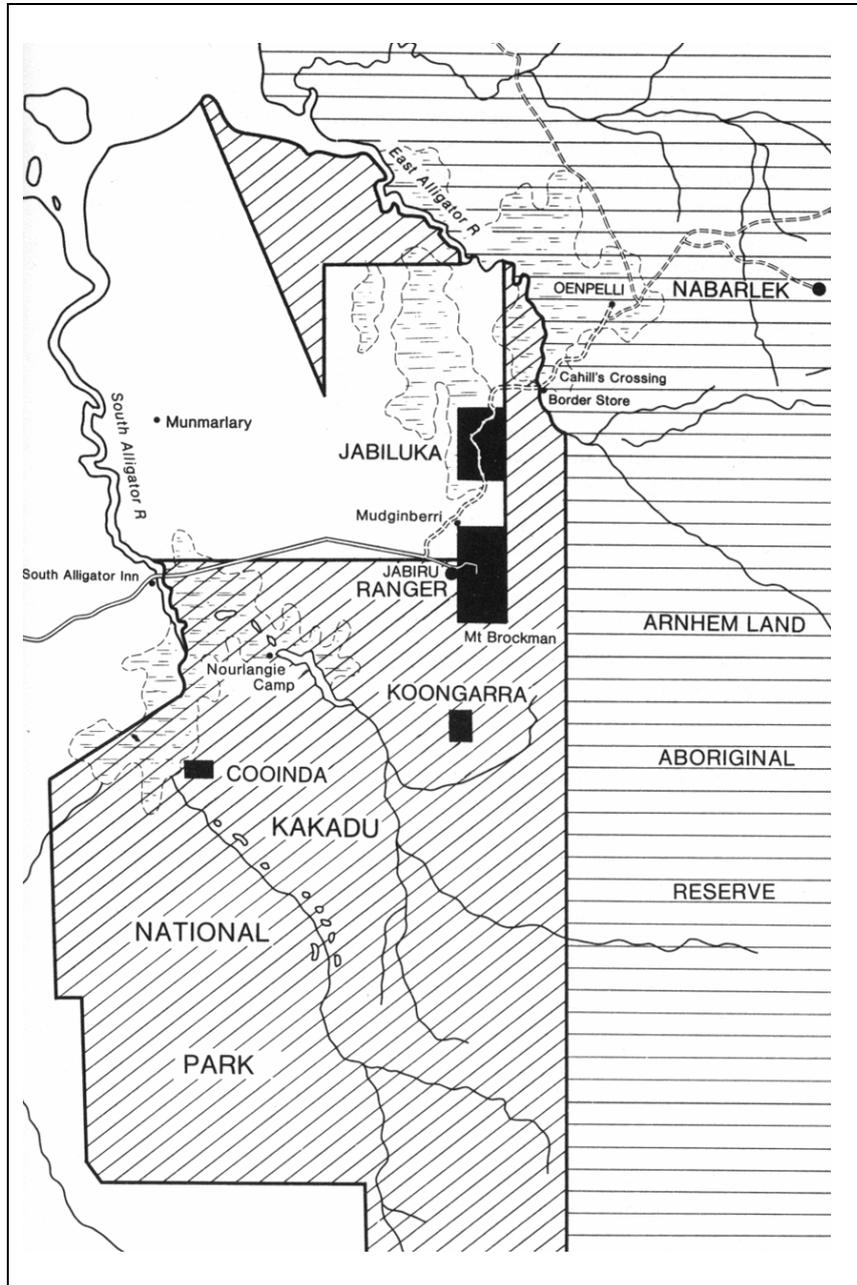


Figure 2. The Uranium Province and Kakadu Region (after Tatz 1982:123)

The research and the monitoring topics were wide-ranging, embracing anthropological, administrative, demographic, economic, historical, legal, linguistic, educational, socio-medical and ecological techniques and themes. With hindsight, there were other issues, factors and impacts that could, or should, have been addressed, including greater attention to base-line health data, fertility patterns, stillbirths, birth defects, learning difficulties among children and health impacts generally arising from a new industrialised environment. Several of these omissions are addressed in the template recommended in Section IX below.

The UPSC submitted six-monthly reports to the Minister.³⁴ Each treated most of the topics listed above. The UPSC's consolidated report, *Aborigines and Uranium*, was submitted to the (then) Minister for Aboriginal Affairs, Clyde Holding, on 30 June 1984. The final recommendations were, in brief:³⁵

- The Fox Report's major recommendations on minimising adverse social effects on Aborigines had *not* been instituted, including ascertaining the health needs of every individual in the Region.
- A number of the Fox forebodings had *not* been realised: consequent upon mining, there had been no undue exacerbation of the alcohol problem, no increase in racial tension, no [new] introduction of sexually-transmitted disease, and neither great intrusion into Aboriginal privacy nor damage to significant cultural sites.
- Royalties had led to the growth of Aboriginal economic and political institutions, producing a hitherto unknown Aboriginal involvement in political and negotiating processes.
- Mining revenues had led to a dependence on these sources of income, leading to a decline in the hitherto productive aspects of Oenpelli's economy.
- A 'money greed' had developed in the Region, leading to some alteration in the traditional Aboriginal 'sharing economy'. There were now two classes of persons — those entitled to royalty payments and those who were not, and 'sharing', at least of money, was no longer a traditional practice.
- Despite mining company encouragement in the field of employment and training, the lack of numeracy and literacy skills hampered genuine Aboriginal employment in the two mines.
- Aboriginal alcohol consumption had 'a life of its own', with its own politics and economics. Mining, of itself, did *not* increase alcohol-related problems.
- The Oenpelli community was declared a 'dry' area in September 1981, yet by May 1984, 81 permits — a significantly large number — had been sought by residents to consume liquor at home.
- Mining royalties had led to more vehicle purchases and greater access to alcohol outlets.
- The system of 'protective custody', not necessarily, nor in most cases, a result of a criminal offence as such, accounted for seventy per cent of Aboriginal arrests in

³⁴ A total of ten monitoring reports were submitted to the Minister for Aboriginal Affairs between 31 December 1978 and 31 March 1983.

³⁵ AIAS 1984:292–306.

the Region. ('Custody' involved police placing people under the influence in cell 'care' until they were sober.)

- 'Aborigines did *not* have the benefit of adequate information or education about uranium, its uses, and the problems inherent in mining and milling the element. Most of the people were ignorant of the subject; many were confused about radiation; several groups showed anxiety about spillages and their effects on water and on items of traditional diet.'
- The Fox prediction that Jabiru Town 'will potentially be very damaging to the welfare and interests' of Aborigines had *not* come to fruition.
- Kakadu National Park proved to be an effective buffer, as Fox had hoped, and had generally promoted Aboriginal interests.

Despite many Fox misgivings *not* having eventuated, the final verdict of the UPSC was an unhappy one: that the Aboriginal community in the Region was a *society in crisis*. The then current civic culture was 'one in which disunity, neurosis, a sense of struggle, drinking, stress, hostility, of being drowned by new laws, agencies and agendas are major manifestations'.

The civic culture was so fragile, it was argued, that there should be no new developments for at least ten years — to allow the community a breathing space. 'There should be continued monitoring of the social impact of uranium mining in the Region ... with a stronger formal link with the Office of the Supervising Scientist.' What was needed was not only continued monitoring of uranium impacts, but of development projects in general. Finally.³⁶

Uranium is a hazardous substance. There must, therefore, be immediate Government intervention in the form of serious and substantial education for Aborigines about what it is, why we need it, what we do with it, and how dangerous it can be to their natural diet, their environment and their physical lives. The Project would be remiss if it did not express its concern about radiation safeguards and their enforcement for all residents in the Region.

V. SPILLAGES AND SILENCES

The consolidated *Aborigines and Uranium* report was delivered to the Minister's office on Saturday, 30 June 1984. The next weekend, a leaked set of its major recommendations appeared in the [then] *National Times*.³⁷ This 'preview' caused anguish within the AIAS, but the content of the report produced little further media attention. It was, so to speak, a one-morning stand.

The Minister for Aboriginal Affairs tabled the report some ten minutes before Parliament closed for that year in October 1984. There was time only for lodgement — there was no acknowledgement, let alone debate. The six-year social impact exercise was simply never discussed in the nation's political forum. Nor did it appear to receive

³⁶ AIAS 1984:304.

³⁷ Milliken 1984.

any attention, let alone mention, during subsequent debates, discussions or inquiries about mining uranium.

Was it a ‘bad’ or deficient study? Reviewing it some twenty-two years later, it appears solid, efficient, professional, and neither unduly radical nor hyper-critical. The ‘breathing space’ of ten years became, in fact, more than twenty years. The recommendation that Aborigines abstain from partaking of the food chain went unheeded, as one might have expected. The study could not, and did not, stop spillages and contamination of the physical (and Aboriginal) environment. Nor did the study convince anyone about the need for continued monitoring. But, in our view, the bulk of *Aborigines and Uranium*, apart from changes in some statistics — in the nature of the local money economy, and in personnel — is as valid today as it was in 1984.

For just over twelve years there was silence on the effects of uranium mining on the Aboriginal population. In late October 1996, an Aboriginal Project Committee (APC) began an eight-month Kakadu Region Social Impact Study (KRSIS), jointly funded by the Commonwealth and Territory governments, the NLC and Energy Resources of Australia (ERA), owners of the Ranger mine.³⁸ Of interest is that this and subsequent reports on action and implementation were published by the OSS — an agency that had displayed little interest in the domain of *social* environment issues. The final KRSIS report, dated June 1997, was followed by a ‘Community Action Plan’ in July 1997, and by two implementation team ‘Reports on Initiatives’, chaired and written by former federal parliamentarian Bob Collins in 2000.³⁹

These reports dealt, in the main, with the need to upgrade housing and outstation infrastructure; to improve Aboriginal life-chances; to service the needs of the aged and disabled; to provide the young with organised sport; to recruit and train Aboriginal workers; to create more educational opportunities; to enhance Aboriginal input into alcohol control strategies; to pay more attention to ante-natal and infant nutrition; and to find more effective ways of managing and handling royalty receipts. These reports stated that the social problems of the Region in the 1980s were ‘unimproved’; further, that Aborigines were critical of the performances of a number of key organisations — the NLC, the Environmental Research Institute of the Supervising Scientist (ERISS), Parks Australia North, Jabiru Town Council and the ERA mine.

There were several surprises. First, apart from a fleeting reference to the first major monitoring exercise, the essence of *Aborigines and Uranium* did not rate a serious mention. There was one sentence to the effect that the UPSC’s insistence on continued monitoring had been ignored by government. Second, a model for permanent social impact monitoring was produced, which suggested that ERISS might be the best body to undertake the work. The KRSIS Committee treated this ‘sceptically’, as ‘a result of distrust over ERISS’s past failure to communicate its research results or involve Aboriginal people in its work’.⁴⁰

A third surprise from APC was its silence over possible health ill-effects from mining as such. The initial APC report mentioned, briefly, that thirty-four per cent of

³⁸ KRSIS 1997a [KRSIS](#).

³⁹ KRSIS 1997b; Community reports June 2000 and November 2000 [KRSIS2](#).

⁴⁰ KRSIS 1997a: Executive Summary.

hospital admissions of Kakadu residents related to pregnancy and childbirth and that eighty-three per cent of those had complications. The hospitalisation rate for those aged 0 to 4 years was just over fifty per cent, with perinatal issues accounting for twenty-four per cent, infectious and parasitic diseases sixteen per cent and respiratory disease twelve per cent.⁴¹ On the face of it, these figures and rates seem high, but no mention was made of comparative data from other regions of the Northern Territory — possibly because no such data were available.

A subsequent KRSIS *Community Report*, for the period November 1998 to November 2000, recommended that ‘NT Health Services make a concerted effort to establish key baseline health indicators and a system for reporting and monitoring by the Jabiru Health Clinic’. This recommendation was said to have arisen because of an undertaking by the NT health agencies ‘to support environmental health services to remote communities’.⁴²

Since then, there has only been silence on social impact monitoring in relation to Aborigines. But there has been much noise about the more than 120 ‘mishaps’ that have ‘befallen’ Rio Tinto’s [ERA] operation in the Kakadu area.⁴³ ‘The [Ranger] mine has six or seven years to run; no more breaches should be tolerated.’ Thus argued Melbourne’s *The Age* newspaper in 2004.⁴⁴ In 1982, one of the authors (Tatz) had written about the first major spillage of water from the allegedly fail-safe tailings ponds:⁴⁵

The truth of the matter is that there is no totally safe commercial system of waste disposal in uranium mining. ... The spillage has spilled. Our focus must now be on the potential effects of those processes on Aboriginal health.

The first spillage occurred on 6 March 1981, when a tailings holding pond at Narbalek overflowed during Cyclone Max, releasing water containing radium-226. No reports of the incident were filed to the Supervising Scientist or to the Territory and Commonwealth governments, as was required by law. The OSS criticised high dust levels, the spillage, and dusting of chemicals that indicated ‘inadequate housekeeping and control of surface contaminants’.⁴⁶

On 5 November 1981, small islands appeared in the tailings pond at the Ranger mine. Radioactive wastes were exposed. The matter was not reported until 19 November that year. Four days later, the Minister for Mines and Energy closed the mine, pending further investigations. A further four days later, the Minister waived the regulation requiring *a two-metre covering of water over tailings at all times*. Within four years of the Fox Report and its insistence on water-cover safeguards such as this, there was a retreat from his philosophy and his standards, with talk of his Report’s ‘archaic’ nature and its ‘irrelevance’ by 1981!

⁴¹ KRSIS 1997a:22–23.

⁴² KRSIS *Community Report*, November 2000:39; *Community Report*, June 2000:33.

⁴³ Anonymous 2004a.

⁴⁴ Anonymous 2004b Dangerous [The Age](#).

⁴⁵ Tatz 1982:87.

⁴⁶ Supervising Scientist, *Annual Report*, 30 June 1981:19–20.

The House of Representatives Standing Committee on Environment and Conservation reported on the Ranger Uranium water management system in October 1986.⁴⁷ Since 1981, 'there have been 24 occurrences involving the water management system, of which 16 related to failures in the tailings pipeline or tailings dam seepage collector lines'. The OSS used the word 'occurrences' to describe these 'accidental releases'. The Northern Territory Environment Centre (NTEC) 'argued that mine management has a poor attitude to environmental protection and continually seeks least cost solutions'.

The Standing Committee praised the mine's co-operation, but concurred with the NTEC and NLC that the number of failures in the water management system was 'alarming'.⁴⁸

The Committee cannot accept that a Company which is located within an area of significant environmental value, claims to be as efficient as any operation in the world and claims to be one of the most regulated in the world, should have allowed the number of incidents to have occurred as have been reported in the annual reports of the Office of the Supervising Scientist Notwithstanding ... the Committee accepts the Supervising Scientist's assessment that there has been no discernible adverse impact on the environment from these occurrences.

Finally, the Committee noted the Aboriginal traditional owners' opposition to the direct release of water into the environment and recommended an ongoing consultative process between the mine, the Aborigines and the two governments involved.

Since 1981, there have been at least 120 'occurrences' in the form of leakages, spillages of contaminated water and breaches of regulations. In 2005, ERA pleaded guilty to three charges in relation to breaches of water management regulations, even closing the mine for a period in order to 'address the problems'. In his report for 1997–1998, the Supervising Scientist himself insisted that the management of the mine ensure that 'there was no immediate nor long term substantial threat to the surrounding environment of Kakadu National Park': 'I must make it quite clear ... that tailings containment practices and strategies at Ranger are in my view second to none in Australia — or indeed the world'.⁴⁹ But in his 2004 annual report, Dr Arthur Johnston, the Supervising Scientist, described 'a culture of complacency' at the mine. He told ABC Radio that he 'wouldn't describe it as frightening; I would describe it as disturbing'.⁵⁰

Since the late 1990s, a new set of environmental requirements for the Ranger uranium mine has been in place. These include the requirement to 'protect the health of Aboriginals and other members of the regional community'. Despite criticisms of the mine by the Supervising Scientist over the years, his Office's conclusion on safety has been constant as in, for example, a tailings water leak in the year 1999–2000: 'The overall conclusion reached from these assessments was the leak of tailings water had a

⁴⁷ Parliament of the Commonwealth 1986, especially at 14–16.

⁴⁸ Parliament of the Commonwealth 1986:30–31.

⁴⁹ Supervising Scientist, *Annual Report*, 1997–1998:276.

⁵⁰ ABC Radio National, *PM*, 10 November 2004.

negligible impact on the people and the environment.’⁵¹ His ‘Investigation of the Stockpiling and Reporting Incidents at Ranger and Jabiluka 2002’ again emphasised that ‘both the chemical and biological monitoring programs conducted ... demonstrate that this incident did not cause any harm to the environment or to human health’.⁵²

On one hand, we have a scientific regulatory agency which argues that the water management system at Ranger is the best in the world, and that in no instance has there been an adverse impact on the environment or the human population as a result of ‘occurrences’. On the other, there is a constant record of leaks and spillages in ‘a culture of complacency’ that may ‘not be frightening but which is disturbing’. Which is correct?

When the OSS says that there is no adverse effect on the human population, the inevitable question must be: ‘how does it know?’ The OSS has not investigated, measured or monitored cancer incidence, chromosomal abnormalities, stillbirths, birth defects, pregnancy termination rates, or the reasons therefor, among Aborigines *in that specific Region*. Nor has the Northern Territory Department of Health, the Northern Territory Department of Mines and Energy, the NLC, nor any other agency. Our research visit in mid-2005 elicited a consistent and general response to such questions: everyone wants such measuring and monitoring to be undertaken.

On the eve of a resurgence, a renaissance perhaps, in nuclear power generation, and of possible new and extended uranium mines in Australia, it would have been remiss not to attempt to ascertain what impact, if any, the presence of a uranium mine alongside a significant Aboriginal population has had on the health of the residents. AIATSIS was conscious of its own Committee’s conclusion about health hazards in 1984:⁵³

We conclude that Aborigines ought to know about the relationship between uranium and other indigenous communities akin to their geography and situation. For example, there is an increased incidence of lung cancer among Navajo uranium miners; there is uncontested evidence that when leukaemias and other cancers present themselves, it is usually between 20 and 25 years after exposure rather than initially. We can see no justification for the non-availability and non-dissemination of these findings.

We note that some twenty-two years later this lack of information is still a feature of the industry. The Uranium Industry Framework Steering Group report, directed by Dr John White for the Minister Ian MacFarlane in September 2006, emphasised the ‘lack of appropriate and adequate information [that] may impede indigenous groups’ understanding of the impact of exploration and development’, particularly in the case of uranium mining.⁵⁴

⁵¹ Supervising Scientist, *Annual Report 1999–2000*:11 [SS](#).

⁵² Environment Australia, Supervising Scientist 2002:7, 13, 16, 17, 19 [SS2](#).

⁵³ AIAS 1984:186.

⁵⁴ Anon. 2006:43. <http://www.industry.gov.au/assets/documents/itrinternet/Uranium-I-F20061110152858.pdf>

VI. A DUTY OF CARE

The UPSC consulted various specialists, including the archaeologist and human ecologist, Dr Carmel Schrire, of Rutgers University in New Jersey. In her report to the Committee, she relied heavily on the work of J.K. Wagoner,⁵⁵ an epidemiologist who had written about the effects of uranium mining, and on the findings of the British Columbia Royal Commission into the health dangers of uranium mining.⁵⁶ Dr Schrire wrote:⁵⁷

If caution is called ‘social responsibility’, we suggest that any committee holding a brief to act in the Aboriginal interest has first and foremost to protect the health of present and future generations — albeit at the very slight inconvenience of industrial concerns.

What Dr Schrire had in mind then is what we have in mind today: that it is common sense to begin substantial data collection and ongoing monitoring of both social and health aspects *now* rather than await both human casualties and disastrous law suits that may well follow. The recent experience of the tobacco, pesticide and asbestos industries should ring alarm bells for those who produce potentially hazardous materials.

In line with similar concerns being expressed by Native American communities in the United States, the UPSC reports expressed concern about the lack of information and education for the Aboriginal community regarding potential hazards of uranium mining. It even suggested a ban on hunting and foraging, given that Mudginberri freshwater mussels, part of the traditional Aboriginal diet, contained high concentrations of radium-226.

What has happened over the more than twenty years since mining went ahead in Kakadu? The federal government did not accept the compelling case for sustained monitoring. Apart from a brief, one-off impact assessment exercise in 1996–97, there has been no subsequent ongoing surveillance, no continuing research, no monitoring and reporting, let alone any reacting to changes. The one constant source of monitoring, the OSS, did not mention Aborigines in its annual reports from 1978 until the year 1999–2000. The report for that year briefly addressed the matter of ‘Community Relations — Interacting with the Aboriginal Community’.⁵⁸ There are also, as we see below, some notable deficiencies in health data collections in the Northern Territory.

In 1984, the UPSC report made a few predictions: among them, that health hazards might become evident many years after the commencement of uranium mining in the Kakadu Region.⁵⁹ More than enough time has elapsed to allow for a study of possible late onset adverse health effects. Accordingly, Colin Tatz, in 2004, raised the matter of

⁵⁵ Wagoner 1964, 1965 et al [Wagoner](#).

⁵⁶ BCRCI 1980 [BCRCI](#).

⁵⁷ Schrire 1982:52–3.

⁵⁸ Supervising Scientist, *Annual Report, 1999–2000*, 44–5.

⁵⁹ AIAS 1984:178–191.

the 1978–84 predictions with the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). He recommended a follow-up study as a way of fulfilling the duty-of-care arising from the original commission. In 2005, the Institute supported a small-scale exploratory research visit by Professor Tatz and his colleagues to determine whether or not the predicted higher cancer and birth defects rates have eventuated in Aboriginal residents of the uranium province. Tatz considered that, if the incidence of, and mortality due to, specific-site cancers had *not* increased over that time, that would be a significant finding worth reporting; if there had been increases, then a major research study might be warranted. In the end, the authors decided that a monitoring model would be more useful than an attempt to examine retrospectively all the factors involved in the causes of Aboriginal ill-health.

VII. THE 2005–2006 EXPLORATION

The geographic and demographic contexts of the Northern Territory (NT) are important in this study. The NT is large — at 1 349 129 square kilometres (or just on 521 000 square miles), it is larger than France, Germany and Italy put together — but it has a minuscule population density of 0.15 persons per square kilometre. In mid-2006, 201 888 individuals occupied this space, just over 100 000 of them in one city, Darwin, by far the largest centre in the NT. At least 58 500 inhabitants of the Territory are Aboriginal, some twenty-nine per cent of the total.

Small raw numbers tend to give an impression that there are small problems. But even in small domains there can be, and there are, significant ratios and strong indicators of a disproportionate prevalence or incidence of a particular medical (or social) problem.

This exploratory study took the form of reviewing the literature on mining hazards and safety in Australia and abroad, revisiting papers and reports on social impact monitoring both here and abroad, extracting material from John Condon's doctoral thesis and research papers on cancer among Northern Territory Aborigines, having discussions with numerous persons concerned with these issues (see list of interviewees in the Appendix), consulting the NT Cancer Registry, attempting to gain access to the NT Birth Register (which includes stillbirths data) and the Congenital Malformations Register, meeting with the Supervising Scientist, having discussions with several medical practitioners and research specialists in Darwin and Melbourne, and visiting Jabiru and the Ranger mine.

(1) Potential data sources

Monitoring health status and adverse events in the Aboriginal population of Kakadu and surrounding regions was never going to be easy. For many purposes, the Territory tends to be lumped into a single entity, without distinction between the dry desert 'Centre' of Australia and the tropical and monsoonal environ of the 'Top End'. Government agencies do not demarcate or enumerate place-specific boundaries such as 'the uranium province'. While a monitoring system was recommended by the UPSC in 1984, no specific system was established to monitor the health of persons living in the Kakadu Region after the establishment of the Ranger and Nabalek uranium mines. No prospective data collections were established of either the population resident in this area or of health problems that might have been related to these specific mining activities.

The only sources which might identify adverse health events are data collected for other reasons. Several disease registers and other data collections could potentially be used to assess health status and particular diseases for the Kakadu population. These include the NT Cancer Register, the NT Births Register (including stillbirths), and the NT Congenital Malformations Register. The cancer and congenital malformations registers are the data sources most relevant to a retrospective assessment of health problems in the Kakadu population. The NT Midwives' Data Collection, which records clinical details of every birth, might also provide useful information about birth weight and the incidence of pre-term deliveries.

(2) The Aboriginal population of the Kakadu Region

As there has been no prospective monitoring of the Kakadu Region population, a list of long-term residents of the Kakadu Region, recording the time each resident has lived in that Region, is not available. Such a list could possibly be gathered retrospectively, using records from health centres, schools, social services, housing and similar agencies, supplemented with interviews with each person to confirm the accuracy of these records. This would be unduly time-consuming and labour-intensive and might not provide accurate data, especially for the earlier years. Accurate retrospective data over the past twenty-five years on each person's periods of residence in and out of the Kakadu Region would require individual interviews of each resident or a representative of each family. Such a retrospective collection would most likely be unreliable: Aboriginal residents of remote communities move constantly between one community and another, and between such communities and Darwin. Nor is it likely that anyone has kept records of such changes of residence.

A less accurate assessment of the Aboriginal population of the Kakadu Region can be obtained by taking the estimated resident population of the Region for each year as the 'average' number of persons living in the Region for that year, that is, ignoring individual migration. Population estimates are produced by the Australian Bureau of Statistics (ABS) based on the Australian census, conducted every five years. For small population areas like the Kakadu Region, the ABS produces estimates for the year in which the census is conducted, but not for the intervening years. Kakadu population estimates are available for 1996 and 2001 only.

Because of our reliance on ABS population statistics, the geographical boundaries we demarcated were those used by the ABS to produce population statistics. The ABS geographical areas that most closely approximate the Kakadu Region are the Jabiru Town Statistical Local Area (SLA), the South Alligator SLA and the Oenpelli Census Collector District (CD).

This approach provides, at best, an approximate estimate of the population potentially exposed to environmental uranium contamination. The location of persons diagnosed with cancer is based on their place of residence at the time of diagnosis (see below). The identification of persons with cancer as residents of the Kakadu Region takes no account of whether or not they had moved there shortly before their diagnosis, with little or no consequent potential exposure to environmental radiation contamination. Conversely, long-term residents of the Region, who had moved elsewhere before being diagnosed with cancer, will not be identified as residents.

Because no new communities have been established and no old ones abandoned, there have been no large-scale movements into or out of the Kakadu Region since uranium mining began. However, some migration of individuals and families has

occurred. The exact population potentially exposed to environmental uranium contamination, and the number of cases of cancer arising in that population, cannot be identified in the absence of prospectively-collected records of Kakadu Region residents.

(3) Cancer occurrence in the Kakadu population

The NT Cancer Register records basic details about every person diagnosed with invasive cancer in the Northern Territory, except for those with the very common sun-related skin cancers (basal cell carcinoma and squamous cell carcinoma, relatively uncommon among Aboriginal peoples⁶⁰). The Register records the site and type of cancer, the date of diagnosis, and demographic details of the person — date of birth, sex, Aboriginal or non-Aboriginal status, and place of residence.

The most accurate way to assess whether or not there has been an excess of cancer occurring in long-term residents of the Kakadu Region is to:

- identify each long-term resident of the Kakadu Region (the cohort of potentially exposed persons);
- determine the total time that they have lived in the Kakadu Region (that is, the time they might have been exposed to a relatively high level of radiation);
- identify all cases of cancer occurring in Kakadu residents;
- use cancer incidence rates from the general population to calculate how many cases of cancer would be ‘expected’ to occur in the Kakadu population if the Kakadu population had the *same* incidence of cancer as the general population;
- compare the actual number of cases in the Kakadu population with the expected number to determine whether or not there has been an excess occurrence of cancer in the Kakadu population.

The NT Cancer Registry commenced in 1981, but notification of cases was not complete until 1991.⁶¹ Since 1991, the Cancer Registry estimates that notifications are incomplete by three percent (compared with cancer registries in other States) and that identification of Aborigines is incomplete by about fifteen per cent. If both notification and Aboriginal identification were complete, cancer incidence rates reported for the NT Aboriginal population would be at least fifteen per cent higher than those currently produced by the Registry. The most recent data from the Cancer Registry are for 2003.

We obtained summary statistics from the NT Cancer Registry on the number of cancer cases recorded as occurring in Aborigines who were listed as resident in the Kakadu Region, defined above, in the period 1994–2003. We then calculated the number of cases of cancer that would have been expected to occur in the Kakadu Region Aboriginal population if that population had the same rate of cancer incidence as the total Aboriginal population of the Northern Territory. We used the NT Aboriginal rates of cancer incidence as our ‘expected rates’ rather than total NT or total Australian rates because Aborigines have a very different pattern of cancer incidence compared with non-Aborigines. They do have a similar incidence of cancers combined, but a much higher incidence of some cancers (lung and other smoking-related cancers, cervix, liver, thyroid) and a much lower incidence of other cancers (including bowel, breast,

⁶⁰ Condon et al 2004:240.

⁶¹ Condon and Zhao 2004 [CondonZhao](#); Condon et al 2004 [CondonZhao2](#).

prostate, bladder and skin melanoma). For most cancers, differences in incidence are very likely to be due to different levels of exposure to carcinogens (such as tobacco and Hepatitis-B) and to preventive factors (such as early age at pregnancy, breast-feeding and Pap tests for cervical cancer), although a genetic factor might be involved for some cancers (such as skin melanoma). It is therefore not appropriate to use rates of cancer incidence of predominantly non-Aboriginal populations (such as total Australian or total NT rates) in calculations concerning an exclusively Aboriginal population.

We used the Estimated Resident Aboriginal Population of the Jabiru and South Alligator SLAs and the Oenpelli CD to approximate the average number of Aboriginal residents of the Kakadu Region in 2001. (There are no other population estimates available for this Region for preceding or subsequent years.) We have therefore taken the 2001 estimates as the best available estimate for each year from 1994 to 2003.

Using the 2001 estimates for all years between 1994 and 2003 to calculate the expected number of cases of cancer would probably *overestimate* the number of expected cases, and thus *underestimate* the size of an excess in cases of cancer if an excess had occurred. This is because the total Aboriginal population of the NT increased by seventeen per cent between 1994 and 2003; and it is likely that the average number of Aboriginal persons living in the Kakadu Region also increased between 1994 and 2003. Thus, by using the 2001 population estimate for each year, we have probably overestimated the average number of Aboriginal residents in the Kakadu Region each year before 2001, but slightly underestimated for 2002 and 2003. For the total period 1994–2003, we have probably overestimated the average number of Aborigines living in the Kakadu Region each year.

(4) Findings

Cancer was diagnosed in a total of 27 Aboriginal persons resident in the Kakadu Region in the period 1994–2003, at least as recorded by the NT Cancer Registry (Table 1). If the Aboriginal population of the Kakadu Region had the same cancer incidence as Aboriginal peoples elsewhere in the NT, cancer could have been expected to be diagnosed in 14.4 persons in this population (all cancers combined) during this period. The actual number of *all* diagnosed cancers was ninety per cent higher than the expected number, *a statistically significant difference*, in other words, one which is not due to chance but which suggests cause and effect.

Table 1: Actual and expected number of cancer cases in the Aboriginal population of the Kakadu Region, 1994–2003

Site	Actual cases	Expected cases	Ratio*	(95% CI)†
Lung	4	2.6	1.5	(0.4–3.9)
All cancers	27	14.4	1.9	(1.2–2.7)

* The actual number of cases divided by the expected number (adjusted for age). A ratio greater than 1.0 indicates that the cancer occurs more frequently in the Kakadu Aboriginal population than in total NT Aboriginal population.

† 95 per cent Confidence Interval. A confidence interval which does not cross 1.0 indicates that the difference between the actual and expected number of cases is not due to random variation (that is, the difference is ‘statistically significant’).

The actual number of lung cancer cases was slightly higher than the expected number (four actual compared with 2.6 expected), but this difference is not statistically significant. Based on this evidence, the incidence of *lung* cancer, unlike *all* cancers, in Aboriginal residents of the Kakadu Region, cannot be said to be greater than that for Aboriginal persons elsewhere in the NT.

The actual number of thyroid cancer cases was slightly less than the expected number (no actual cases compared with 0.5 expected cases), but this difference is not statistically significant. There is no evidence that the incidence of thyroid cancer in Aboriginal residents of the Kakadu Region is greater than that for Aboriginal peoples elsewhere in the Northern Territory.

The excess of all cancers combined is not due to an excess of any particular cancer. Although the total number of cancer cases (all cancers combined) was higher than expected, this excess was not restricted to any particular cancer site (that is, site of origin within the body). Other than lung cancer, there were no more than two cases of any particularly cancer diagnosed in Aboriginal persons in the Kakadu Region in this ten-year period and none or only one case for most cancers, including thyroid (no cases), leukaemia (no cases) and lymphoma (one case).

The Kakadu Region is at the western edge of Arnhem Land. Cancer mortality rates for Aboriginal peoples have previously been reported to be higher in the East Arnhem District than elsewhere in the NT (Table 2). However, these rates were based on a small number of cancer deaths (a total of 75 for the ten-year period); confidence intervals were not reported and there was a large degree of variation between the two time-periods reported. Cancer mortality rates for East Arnhem District have not been reported for the most recent ten years, and no cancer incidence rates have been reported for any period. If cancer mortality is high for Aboriginal peoples in the East Arnhem District (that is, the high cancer mortality rates reported were not due to random variation in a small population) and high cancer mortality reflects high cancer incidence it is possible that the causes of excess cancer in Aborigines in the Kakadu Region might be common to Aboriginal peoples throughout the East Arnhem District and surrounding areas.

Table 2: All cancers combined, age-adjusted mortality rate for Aboriginal persons (expressed as rates per 100 000 of the population), East Arnhem District and total Northern Territory, 1986–90 and 1991–95.⁶²

	Male East Arnhem	Male Total NT	Female East Arnhem	Female Total NT
1986–90	656	298	609	227
1991–95	486	369	206	260

⁶² Dempsey and Condon 1999 [Dempsey](#).

(5) Congenital malformations

A similar approach should be able to be taken with congenital malformations as was done with cancer, that is, to ascertain the number of Aboriginal babies born with a congenital malformation to mothers resident in the Kakadu Region, and to estimate the number that would be expected in that Region if the population of that Region had the same incidence of congenital malformations as for Aboriginal peoples in the rest of the NT, or for the total Australian population.

Unfortunately, the NT Congenital Malformations Register *has not been maintained since approximately 2000*, and the data for previous years could not be analysed by the NT Department of Health and Community Services. Assessment of whether or not there is a higher occurrence of congenital malformations in Aboriginal babies in the Kakadu Region is therefore not possible.

This illustrates the most serious potential problem with relying on retrospective analysis of routinely collected data to monitor health problems that might take many years to arise. The data required might not be collected in the level of detail required, the data collection might cease, or data from previous years might be lost. We were unable to ascertain why the Malformations Register has not been appropriately maintained.

(6) Stillbirths

Statistics on the total number of stillbirths born to mothers resident in the Northern Territory are available, but data for small areas such as the Kakadu Region are not published and were not available for this project. Data on stillbirths are available from the NT Midwives' Collection (a database of clinical information about each birth in the NT), but not all stillbirths that occur outside hospital are included. Stillbirths are also recorded in the NT Births Register, but this data source is currently available only to the Australian Bureau of Statistics for its statistical analyses. The NT Department of Health and Community Services is negotiating with the Registrar-General for access to this data source to complement the Midwives' Collection.

Identifying stillbirths to Kakadu mothers would require access to individual birth records to identify mothers resident in this Region. Such data access and analysis would be possible if approved by the Human Research Ethics Committee and by the NT Registrar-General and other authorities. It would require considerable resources to undertake the data coding and analysis. Our project did not have the resources available to undertake such a study, but investigation of data sources indicates that a more intensive investigation would be possible.

(7) Discussion

Our preliminary examination of cancer incidence in the Aboriginal population of the Kakadu Region indicates that the incidence of all cancers is almost doubled when compared with the NT Aboriginal population generally. However, the apparent excess of all cancers combined does not appear to be due to an excess of any one particular cancer. There is no excess of thyroid cancer in this population; indeed, there were no cases at all registered in a ten-year period. There is little evidence of an excess of lung cancer or of any other particular cancer.

We caution that this has to be regarded as a preliminary finding only. We have not been able to verify the accuracy of data recorded by the Cancer Registry, particularly

the place of residence of those recorded as living in the Kakadu Region, nor to confirm the Aboriginal status of all cases recorded in this Region. We have also relied on the 2001 census counts of the Aboriginal population of the region as our sole estimates of the size of the Aboriginal population of the Region.

A more intensive investigation would be required to accurately identify the Aboriginal population of the Region and the number of cancer cases in that population before an excess incidence of cancer could be rigorously established.

This preliminary investigation suggests there is an excess of cancer in the Aboriginal communities of the Kakadu Region. Our finding of a doubling in the overall cancer incidence rate (that is, the incidence of all cancers combined) is *a cause for serious concern and further investigation is clearly warranted*.

We note that there is no comparable, definable Aboriginal community in the Territory with this kind of cancer profile, yet Kakadu Aboriginal lifestyle choices are similar to those of other Aboriginal groups in the Territory. In general, the cancer incidence for Territory Aborigines is not much higher than for non-Aborigines across the Territory, yet it is much higher for Aborigines in the Kakadu region. There could be reasons for the high cancer rates we have identified other than proximity to uranium mining and milling. It is important to note that the existing data cannot help to clarify this question. That is why it is essential to establish appropriate monitoring.

VIII. SOCIAL IMPACT ASSESSMENT

Social impact assessment (SIA) has come a long way since the UPSC consulted the pioneering work of C.P. Wolf in the late 1970s. There is now an International Association for Social Impact Assessment (IAIA). It defines SIA as ‘an umbrella or overarching framework that embodies the evaluation of all impacts on humans and the ways in which people and their communities interact with their socio-cultural, economic and biophysical surroundings’.⁶³

The approach in the new SIA international principles makes no distinctions between the biophysical and the social domains. The comprehensive template is permeated by a concern for equity, especially for racial and ethnic minorities. The IAIA insists on a human rights platform, one that ensures ‘participatory processes’ and a ‘co-ownership’ rather than a ‘stake-holding’ status for those peoples who are, essentially, the target of the whole analysis, monitoring and management process.

SIA is now seen as *proactive* — no longer merely or only the identification or amelioration of negative and/or unintended outcomes of a development project.

SIA practitioners assert that impacts must include the effects of a development on cultural heritage, on a community, Aboriginal rights, health and mental health, leisure, political life, the local economy and on local resources. Hence, SIA has to be an inter-agency and teamwork exercise.

⁶³ IAIA 2003:2 [IAIA](#).

One aim is the empowerment of the local peoples and their co-ownership of the SIA processes. Herein lies a serious problem, both for the *status quo* and for any monitoring on the lines recommended in section IX below. There are several agenda items that Aborigines in the Kakadu Region can either self-monitor or contract, and in which they can certainly participate on an equity basis: how they live, work and play day-to-day; their cohesion, services and functions; their participation in political life and in decision-making. Some SIA agenda items are highly technical and the local community must either hire, or be assisted in hiring, persons who can analyse and report to them on, *inter alia*, the quality of their air and water; the adequacy of their sanitation, garbage disposal and electrification; their physical safety; the value of the food they eat; and the hazards of noise and dust.

Some agendas must, for the foreseeable future, remain in the hands of health and medical professionals who alone can measure, record, diagnose and prescribe — the incidence and prevalence of certain diseases, abnormal births, chromosomal damage, cytology testing and radiation hazards. Inevitably, the key health hazards of uranium mining and milling will have to be monitored by non-Aboriginal specialists. The SIA recognises that such situations will occur, but they do enumerate several guiding principles that we, in turn, support as fundamental to the monitoring model we propose.

First, a ‘precautionary approach’ is always preferable. Lack of certainty about outcomes, and particularly on topics about which there is either debate or emotion, should never be a reason for refusing to implement mitigation measures and stringent monitoring. Second, there should be a concern for ‘intra-generational equity’, that is, impacts should not be allowed to fall unduly on women, children, the disabled and ‘the socially excluded’. Third, it is essential that we recognise cultural and social diversity and avoid the imposition of universality because that approach is considered either more cost-effective or efficient. Fourth, and perhaps most importantly, there must be a preference for ‘the prevention principle’, that is, to proceed on the basis that it is cheaper in the long run to prevent negative social impacts and ecological damage than it is to restore, rectify or in some way treat the damage after the event.

IX. MONITORING MINING HAZARDS: AN INTEGRATED MODEL

We can, however, do much better than has been done to date. We can establish a template for a continuing monitoring of both social and health impacts of uranium mining on Aboriginal communities. Such sustained monitoring is not simply, or only, protective of Aboriginal communities riven by ill-health: it would also provide all professional departments with a ‘check-list’ for earlier diagnoses and treatment of problems, and assist organisations like the NLC in maintaining its duty of care of Aboriginal interests. It would enable mining companies to improve their safety operations, their environmental care, forestall potential lawsuits, and certainly enhance or establish their reputations as good corporate citizens.

Monitoring is not an alien concept. The Uranium Industry Framework Steering Group has suggested regular monitoring of changes in legislation affecting Aborigines,

and monitoring land use agreements.⁶⁴ Monitoring Aboriginal health is also consonant with the major recommendation of the Steering Group, namely:

Recommendation 15:

The uranium industry, the Australian Government and State and Territory governments, in partnership with relevant Indigenous communities and organizations will develop:

- a comprehensive science-based information package specifically for Indigenous audiences, aimed at raising general awareness of the uranium mining sector and addressing key areas of concern, everyday analogies and presented in a variety of accessible formats
- arrangements to support ongoing dialogue and information exchange between Indigenous communities and organizations, the uranium industry and relevant government agencies, initially between the Northern Territory and South Australia.

This exploratory research has reversed our earlier aim — which was to examine whether or not a full-scale, consortium-style *retrospective* research project was warranted into the uranium–Aboriginal health relationship. That perspective has changed to a future-oriented model for a sustained monitoring exercise. This template is not aimed solely at the Northern Territory — it could well be of service for uranium companies universally, especially those operating alongside Aboriginal communities.⁶⁵ Sustained monitoring means an *unbroken* set of protocols and audits while mining exists; in the case of uranium, given the North American experience, monitoring should continue for at least two decades after the mines cease operating.

The proposed model comprises three major platforms: specific socio-economic indicators, and what we term personal and non-personal health services for Aborigines living adjacent to the mining of minerals. Different agencies have differing responsibilities — hence no attempt is made here to allocate functions or specialist services by department or agency. Those decisions are matters for the Northern Territory and federal governments and for non-governmental organisations and associations. However, the subjects and agendas suggested here need to be factored into the suggested holistic monitoring model.

(1) Promotion of health and well-being

Maintaining the good health of the individual, as defined by the World Health Organisation, involves maintaining physical, social and mental well-being. Among others, the key factors that promote such well-being (or wellness) are:

- adequate wages;
- conditions of, and being in, employment;
- general education;

⁶⁴ Anon. 2006:47 <http://www.industry.gov.au/assets/documents/itrinternet/Uranium-I-F20061110152858.pdf>.

⁶⁵ Our model might well apply to the health of communities living alongside the mining of other minerals, such as bauxite, manganese, lead and zinc. Each of these minerals has a body of literature devoted to the health hazards involved in their mining and processing.

- health education, especially on hazards that might be involved in mining or milling processes;
- housing — its nature, suitability and adequacy (from an Aboriginal perspective);
- nutrition;
- physical exercise, leisure and recreation;
- social service benefits, their nature and distribution;
- transport systems and their adequacy.

These issues, which profoundly affect Aboriginal well-being, do pose significant challenges to all levels of government and the community. Housing has always been contentious, with few success stories. Many remote communities are interested in housing solutions that differ from the Australian ideal. Despite problem areas, monitoring teams need to include existing knowledge, whether statistical or anecdotal, written or oral, on these matters: all are central to the health status of *any* population. Academic staff and postgraduates students of Charles Darwin University, section heads of the NLC, and specialists in Aboriginal economies at The Australian National University can provide, at the least, *annual briefs* on several of these items.

(2) Preventive health services

Community-based health services should be provided at all vulnerable stages of life. These services are often based on the family as a unit and on periodic examinations through —

- ante-natal clinics;
- immunisation services;
- infant welfare clinics;
- school health services;
- screening programs; and
- routine examinations of adults.

Preventive medicine is now recognised universally. Aboriginal health is recognised by all as precarious and most Aboriginal communities have *lesser* access to resources and facilities. Preventive health services require serious attention. The Northern Territory has — with the exceptions mentioned — a well-developed, health sector-wide approach to improving maternal and child health and general adult health. Nevertheless, very significant health challenges remain, and certain areas might be key to monitoring the effect of developments, like uranium mining, on the health of communities:

- Maternal and child health — birth outcomes, particularly stillbirths, birth-weight, congenital malformations and perinatal mortality; growth and development during childhood; immunisation rates; prevalence of otitis media and significant hearing loss;
- Adult health — monitoring the uptake and results of well-adult health checks; focus on behavioural risk factors of diet, smoking, alcohol, exercise, pathophysiological risk factors of obesity, blood pressure, lipid abnormalities, urinary protein; prevalence of diabetes, cardiovascular diseases and chronic kidney disease;
- Cancer — monitoring overall cancer rates, and in addition — due to the high sensitivity of particular body tissues to cancer induced by radiation — monitoring rates of lung, thyroid, leukaemia and female breast cancers;

- Psychosocial health indicators — monitoring a range of health and social issues around hazardous alcohol intake, rates of suicide and attempted suicide, and of sexually-transmitted diseases.

While many of these activities are being carried out, a monitoring agency should pull all the components together and make sense of the relationship of the ‘parts’ to each other and the parts to the whole. The social, economic, political, geographic, historical and legal factors leading to ‘illness’ must be central considerations with regard to the impact of mining and development on community health.

(3) Personal curative services

These include clinic, hospital, outpatient and specialist health and medical services. Attention should be paid to the numbers and distribution of medical and other health care personnel. Statistics often paint a picture of adequate ratios of doctors to populations, whereas there is all too often a serious maldistribution, particularly in remote Aboriginal communities. Cross-cultural training is given inadequate attention in the education and training of health professionals to work with Aboriginal Australians. For Aborigines with chronic disease who need to access hospital services, miscommunication has been shown to profoundly affect health outcomes. Sources of miscommunication include lack of patient control over the language, timing, content and circumstances of interactions; differing modes of discourse; the dominance of biomedical knowledge and marginalisation of Aboriginal knowledge; absence of opportunities and resources to construct a body of shared understanding; cultural and linguistic distance; lack of staff training in intercultural communication; and lack of availability of trained interpreters.⁶⁶ These problems have also been documented with regard to health in the primary care setting in remote communities.⁶⁷

(4) Personal database collections

These include the registers for cancer, stillbirths and congenital malformations, the Midwives’ Collection (containing clinical details of each birth), and the communicable disease notification system. These collections need to be adequately maintained and reported upon specifically for the population affected by uranium mining. The AIHW National Perinatal Statistics Unit has difficulties with the lack of uniformity in state and territory reporting of birth anomalies.⁶⁸ Some jurisdictions seem not to consider such databases as important. Given that South Australia has an excellent system, there might be a way ahead for a conjoint operation between that state and the Territory.

(5) Personal rehabilitative services

These include the health, education and re-employment of persons who have suffered serious illness.

⁶⁶ Cass et al 2002 [Cass](#).

⁶⁷ Trudgen 2000 [Trudgen](#).

⁶⁸ Dr Elizabeth Sullivan, AIHW National Perinatal Statistics Unit, personal communication.

(6) Environmental health services

Environmental health services and basic public health infrastructure in remote communities, the quality of which is taken for granted by the general Australian population, are often inadequate to maintain health. These services include:

- drainage;
- electricity;
- excreta and garbage disposal facilities;
- food handling and feeding;
- road availability and maintenance;
- water supplies.

These have been perennial concerns in the Northern Territory and other jurisdictions, yet they remain either unresolved or only partly resolved. These social, political and economic issues impinge directly on health and well-being, and, as such, cannot be ignored because they appear to be outside the regular domains of the health professions.

X. CONCLUSION

All levels of radiation exposure are associated with some increased risk to human health.⁶⁹ Radiation attacks the human species at the most basic level — our cellular structure. In 1977, the question of whether or not to mine uranium was resolved in the positive by Justice Fox and the federal government. The issue of monitoring the social and human, rather than only the physical, environment has *not* been resolved.

Monitoring, assessing and reviewing are essential activities for achieving good governance. In the Northern Territory, the Cancer Registry is not only maintained but interrogated, resulting in public information through learned articles and presentations, and by dissemination through the media. The same cannot be said of the Congenital Malformations and Birth Defects registers. There have been enough disasters, human and legal, to capture our attention: for example, the James Hardie Company, its asbestos legacy and its ongoing compensation consequences. There have also been enough nuclear disasters to produce an almost immediate concern at the mention of the word ‘uranium’. Best practice remains control and monitoring of the hazard.

In this paper, we have not outlined a detailed and precise technical manual for monitoring. We have suggested a broad-based and wide-ranging checklist for, at the very least, annual consideration. Universities do not provide training courses for ‘social impact monitors’. However, there are persons with enough generalist education who can become monitors, especially of the social conditions and impacts of an industrial operation such as uranium mining. Two, perhaps three, such personnel for the whole of the Northern Territory should suffice for the kinds of audits we recommend. At least one of these officers should be medically qualified and versed in radiation safety technology.

⁶⁹ Australian Radiation Protection and Nuclear and Safety Agency.

Monitoring can only be effective if it is undertaken by an agency with regulatory powers, and with sufficient mandate to consult the registers and databases that make monitoring a serious rather than a perfunctory exercise. The OSS could well have a new and separate division devoted to monitoring social and health impacts. There should also be formal consultation mechanisms with the NLC and other Aboriginal associations and incorporations affected by the mining of any minerals.

Good business sense would be to find approximately \$450 000 per year⁷⁰ to monitor the social and physical health of Aboriginal peoples living in the communities surrounding current or proposed uranium mines. Such monitoring would represent an investment to prevent the health care costs that could otherwise ensue, and to avoid the possible punitive damages that might lie in wait at some time in the future.

Sustained monitoring will not of itself halt potential ill-effects and hazards emanating from uranium mining and milling. It will provide a series of specific early-warning indicators of medical and social problems that are currently not recognised as the possible consequences of such mining operations.

⁷⁰ This sum would cover the annual salaries of two professional officers, one medically qualified, one senior research assistant and travel funds.

ACKNOWLEDGMENTS

The Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS), Canberra, for its support;

Staff of the NT Department of Health and Community Services, Darwin, for advice on data sources and provision of cancer statistics;

The Human Research and Ethics Committee (HREC) of the NT Department of Health and Community Services and the Menzies School of Health Research for permission to undertake the research and consult medical databases;

Dr Peter Arnold, Sydney, for his professional editing, research assistance and constructive suggestions;

Professor Douglas Booth, Waikato University, Hamilton, for his comments and suggestions;

Dr Patrick Sullivan, Acting Director of Research, AIATSIS, for his constructive comments;

Dr Peter Veth, Director of Research at AIATSIS, for his support.

APPENDIX: INTERVIEWS

Bromwich, Dr Alan, former senior surgeon, Northern Territory Department of Health.

Cebon, Professor Jonathon, Professor of Oncology, Melbourne University.

Cobbett, Professor Chris, Professor of Genetics, Melbourne University.

Dewar, Graham, regional co-ordinator, Western Arnhem Region, Northern Land Council.

Guthridge, Dr Steven, Health Gains Planning Branch, Northern Territory Department of Health and Community Services.

Hore-Lacey, Ian, general manager, Uranium Information Centre, Melbourne.

Houston, Dr Shane, Head, Office of Aboriginal Health, Family and Social Policies, Northern Territory Department of Health and Community Services.

Johnston, Dr Arthur, Supervising Scientist, Darwin.

Kesetven, Sue, former researcher KRSIS Project, Canberra.

Kilburn, Dr Charles, senior paediatrician, Royal Darwin Hospital.

Levitus, Dr Robert, anthropologist, former director KRSIS Project, Canberra.

Lewis, Gareth, anthropologist for Mining and Social Impact, Northern Land Council.

Loy, Dr John, chief executive officer, Australian Radiation Protection and Nuclear safety Agency, Melbourne.

Mearns, David, branch manager, Anthropology Section, Northern Land Council.

Measey, Mary-Anne, NT Department of Health and Community Services.

Morris, Dr Peter, Royal Darwin Hospital.

Selva-Nayagan, Dr Sid, senior oncologist, Royal Darwin Hospital.

Sullivan, Dr Elizabeth, Director, AIHW National Perinatal Statistics Unit, Sydney.

Stewart, Margaret, NT Department of Health and Community Services.

Travis, Susan, manager, NSW Birth Defects Register, NSW Department of Health.

Wellings, Peter, Parks Australia North, Darwin.

White, Ian, anthropologist, Northern Land Council.

Zapantis, Alex, manager, Environment, Safety and Health, Ranger Uranium.

REFERENCES

- AIAS 1984 *Aborigines and Uranium: Consolidated report on the social impact of uranium mining on the Aborigines of the Northern Territory*. Australian Institute of Aboriginal Studies, Canberra.
- Anonymous 2004a Report by the NT Department of Business, Industry and Resource Development. *Sydney Morning Herald*, 1 October 2004.
- Anonymous 2004b Dangerous practices at the Ranger mine. *The Age* 2 September 2004. Accessed August 2006
<www.theage.com.au/articles/2004/09/01/1093938992087.html?from=storylhs>.
- Anonymous 2006 Commonwealth of Australia, Uranium Industry Framework Report of the Uranium Industry Framework Steering Group, p.43.
<<http://www.industry.gov.au/assets/documents/itrinternet/Uranium-I-F20061110152858.pdf>>.
- Au W.W., M.A. McConnell, G.S. Wilkinson, V.M.S. Ramanujam and N. Alcock 1998 Population monitoring: experience with residents exposed to uranium mining/milling waste. *Mutation Research* 405:237–245.
- ARPANSA 2002 *Recommendations for Limiting Exposure to Ionizing Radiation and National Standard for Limiting Occupational Exposure to Ionizing Radiation*. Australian Radiation Protection and Nuclear Safety Agency, Canberra (Radiation Protection Series Publication 1).
- ARPANSA 2005 *Code of Practice and Safety Guide Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing*. Australian Radiation Protection and Nuclear Safety Agency, Canberra (Radiation Protection Series Publication 9).
- BCRCI 1980 *Health Dangers of Uranium Mining and Jurisdictional Questions, A Summary of Material before the British Columbia Royal Commission of Inquiry, Health and Environmental Protection — Uranium Mining*, presented by E.R. Young and R.F. Woollard, Environmental Health Association of the British Columbia Medical Association.
- Boice J.D., M. Mumma, S. Schweitzer and W.J. Blot 2003 Cancer mortality in a Texas county with prior uranium mining and milling activities, 1950–2001. *Journal of Radiological Protection* 23:247–62.
- Boice J., S.S. Cohen, M.T. Mumma, E. Dupree-Ellis, K.F. Eckerman, R.W. Leggett, B.B. Boecker, A.B. Brill and B.E. Henderson 2006 Mortality among radiation workers at Rocketdyne (Atomics International), 1948–1999. *Radiation Research* 166:98–115.
- Brugge, D., J.L. de Lemos and B. Oldmixon 2005 Exposure pathways and health effects associated with chemical and radiological toxicity of natural uranium: a review. *Review of Environmental Health* 20(3):177–193.
- Brugge, D. and R.Goble 2002 The history of uranium mining and the Navajo people. *American Journal of Public Health* 92(9):1410–1419.
- Cass A., A. Lowell, M. Christie, P.L. Snelling, M. Flack, B. Marrnganyin and I. Brown 2002 Sharing the true stories: improving communications between Aboriginal patients and healthcare workers. *Medical Journal of Australia* 176(20 May):466–70.
- Chernobyl Forum 2006 *Chernobyl's Legacy: Health, environmental and socio-economic impacts*. The International Atomic Energy Agency, Vienna, Austria.
- Collins, Bob 2000 *Kakadu Region Social Impact Study Community Report, Report on initiatives from the Kakadu Region community and government on the implementation of the Kakadu Region Social Impact Study, November 1998–June 2000*. Parks Australia North, Darwin.

- Condon, J.R. and Y. Zhao 2004 *Northern Territory Cancer Registry: Data collection, analysis and reporting procedures*. Northern Territory Department of Health and Community Services, Darwin.
- Condon, J.R., Y. Zhao, B. Armstrong and A. Barnes 2004 *Northern Territory Cancer Registry: Data quality, 1981-2001*. Northern Territory Department of Health and Community Services, Darwin.
- Condon, J.R. 2004 *Cancer in Indigenous Australians in the Northern Territory*. Unpublished Doctoral thesis, Menzies School of Health Research and Charles Darwin University.
- Darby S.C., E. Whitley, G.R. Howe, S.J. Hutchings, R.A. Kusiak, J.H. Lubin, H.I. Morrison, M. Tirmarche, L. Tomasek and E.P. Radford 1995 Radon and cancers other than lung cancer in underground miners: a collaborative analysis of 11 studies. *Journal of the National Cancer Institute* 87(5):378–384.
- Dempsey, K.E. and J.R. Condon 1999 *Mortality in the Northern Territory 1979–1997*. Territory Health Services, Darwin.
- Fox, R.W., G.H. Kelleher and C.B. Kerr 1977 *Ranger Uranium Environmental Inquiry, Second Report* [the Fox Report]. Australian Government Publishing Service, Canberra.
- Gottlob P., M. Steinert, M. Weiss, V. Bebesko, D. Belyi, N. Nadejina, F.H. Stefani, G. Wagemaker, T.M. Fliedner and R.U. Peter 2001 The outcome of local radiation injuries: 14 years of follow-up after the Chernobyl accident. *Radiation Research* 155(3):409–416.
- Gould, Stephen Jay 1982 *The Panda's Thumb: More reflections in natural history*. New York, W.W. Norton.
- Graf, W.L. 1990 Fluvial dynamics of Thorium-230 in the Church Rock event, Puerco River, New Mexico. *Annals of the Association of American Geographers* 80(3):327–342
- Howard, J. 2006 Review of uranium mining processing and nuclear energy in Australia. News Room, Canberra. Accessed 6 June 2006
<www.pm.gov.au/news/media_releases/media_Release1965.html>.
- IAIA 2003 *Social Impact Assessment: International principles*. International Association for Impact Assessment, Fargo, ND (Special Publication Series 2).
- KRSIS 1997a *Kakadu Region Social Impact Study, Report of the Aboriginal Project Committee, June 1997*. Supervising Scientist, Darwin.
- KRSIS 1997b *Kakadu Region Social Impact Study: Community action plan 1997, Report of the Study Advisory Group, July 1997*. Supervising Scientist, Canberra.
- Livingston, G., R. Falk and E. Schmid 2006 Effect of occupational radiation exposures on chromosome aberration rates in former plutonium workers. *Radiation Research* 166:89–97.
- Lloyd D.C., J.N. Lucas, A.A. Edwards, W. Deng, E. Valente, P.A. Hone and J.E. Moquet 2001 A study to verify a reported excess of chromosomal aberrations in blood lymphocytes of Namibian uranium workers. *Radiation Research* 155:809–817.
- Lopez-Albente, G., N. Aragonés and M. Pollán 2001 Solid-tumor mortality in the vicinity of uranium cycle facilities and nuclear power plants in Spain. *Environmental Health Perspectives* 109(7):721–729.
- Maddock, K. 1984 Book Review - Aborigines and Uranium and Other Essays. *Aboriginal Law Bulletin*. Accessed 6 June 2006
<beta.austlii.edu.au/au/journals/AboriginalLB/1984/7.html>.
- Meeting Report Low-Dose Radiation Risk Assessment, Report of an International Workshop on Low Dose Radiation Effects, Columbia University Medical Center, New York, New York April 3–4, 2006. *Radiation Research* 166(3):561–565.
- Milliken, Robert 1984 Conference eve report: uranium's impact on Aborigines — Devastating. *National Times* 6 July 1984.
- National Research Council, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation 2005 *Health Risks from Exposure to Low Levels of Ionizing Radiation* (BEIR VII). National Academy Press, Washington, DC.

- Noshchenko A., P.V. Zamostyan, O.Y. Bondar and V.D. Drozdova 2002 Radiation-induced leukemia risk among those aged 0–20 at the time of the Chernobyl accident: a case-control study in the Ukraine. *International Journal of Cancer* 99:609–618.
- Parliament of the Commonwealth of Australia 1986 House of Representatives Standing Committee on Environment and Conservation, Report on Ranger Uranium Water Management System, October 1986 (Parliamentary Paper 273/1986).
- Roscoe R.J., K. Steenland, W.E. Halperin, J.J. Beaumont and R.J. Waxweiler 1989 Lung cancer mortality among non-smoking uranium miners exposed to radon daughters. *Journal of the American Medical Association* 262(5):629–333.
- Schrire, Carmel 1982 The Radiological Hazards of Uranium Mining and Milling with Particular Reference to the Health and Well-being of Aboriginal People in the Alligator Rivers Region, N.T., Australia. Department of Human Ecology, Rutgers University, New Brunswick, New Jersey (Unpublished Technical Paper 2).
- Supervising Scientist, *Annual Reports*, 1997–1998, 1998–1999, 1999–2000, 2002–2003, Department of the Environment and Heritage/Environment Australia, Supervising Scientist, Darwin.
- Supervising Scientist, Environment Australia 2002 *Investigation of the Stockpiling and Reporting Incidents at Ranger and Jabiluka 2002*. Supervising Scientist, Darwin.
- Tatz, C.M. 1982, *Aborigines and Uranium and Other Essays*. Heinemann Educational Australia, Melbourne.
- Tomasek L., S.C. Darby, A.J. Swerdlow, V. Placek and E. Kunz 1993 Radon exposure and cancers other than lung cancer among uranium miners in West Bohemia. *The Lancet* 341(8850):919–923.
- Tomasek, L., A.J. Swerdlow, S.C. Darby, V. Placek and E. Kunz 1994 Mortality in uranium miners in West Bohemia: a long-term cohort study. *Occupational and Environmental Medicine* 51(5):308–315.
- Trudgen, Richard 2000 *Why Warriors Lie Down and Die*. Aboriginal Resource Development Service, Darwin.
- Uranium Industry Framework Report of the Uranium Framework Steering Group, 2006, commissioned by the Minister for Tourism, Industry and Resources, Ian Macfarlane MP, Commonwealth of Australia, Canberra.
- van Dam, R.A., C.L. Humphrey and P. Martin 2002 Mining in the Alligator Rivers region, northern Australia: assessing potential and actual effects on ecosystem and human health. *Toxicology* 181–2:505–15.
- Wagoner J.K. 1964 Cancer mortality patterns among U.S. uranium miners and millers, 1950 through 1962. *Journal of the National Cancer Institute* 32:787–801.
- Wagoner J.K., V.E. Archer, F.E. Lundin, D.A. Holaday and J.W. Lloyd 1965 Radiation as the cause of lung cancer among uranium miners. *New England Journal of Medicine* 273:181–188.
- Wesch H, T. Wiethage, A. Spiethoff, K. Wegener, K.M. Muller and J. Mehlhorn 1999 German uranium miner study — historical background and available histopathological material. *Radiation Research* 152:S48–S51.
- Zaire R, M. Notter, W. Riedel and E. Thiel 1997 Unexpected rates of chromosomal instabilities and alterations of hormone levels in Namibian uranium miners. *Radiation Research* 147:579–84.

THE AUTHORS

Colin Tatz AO, BA (Law), MA, PhD, Hon. LLD — is Adjunct Professor of Politics at Macquarie University, Visiting Fellow in Social Sciences at the Australian National University, and Honorary Visiting Fellow at the Australian Institute of Aboriginal and Torres Strait Islander Studies <cst@aapt.net.au>.

Alan Cass MB, BS, FRACP, Grad Dip Clin Epi, PhD — is Director of the Renal Division, the George Institute for International Health, and Senior Lecturer, Sydney University <acass@george.org.au>.

John Condon MB, BS, FAFPHM, DTM&H, MPH, PhD — is Deputy Director of the Menzies School of Health Research, Darwin <john.condon@menzies.edu.au>.

George Tippett AM, MB, BS, DA, MFARCS — is chairman of the Victorian Medical Benevolent Association and Director of the Dandenong Surgery Centre <gtippett@bigpond.net.au>.