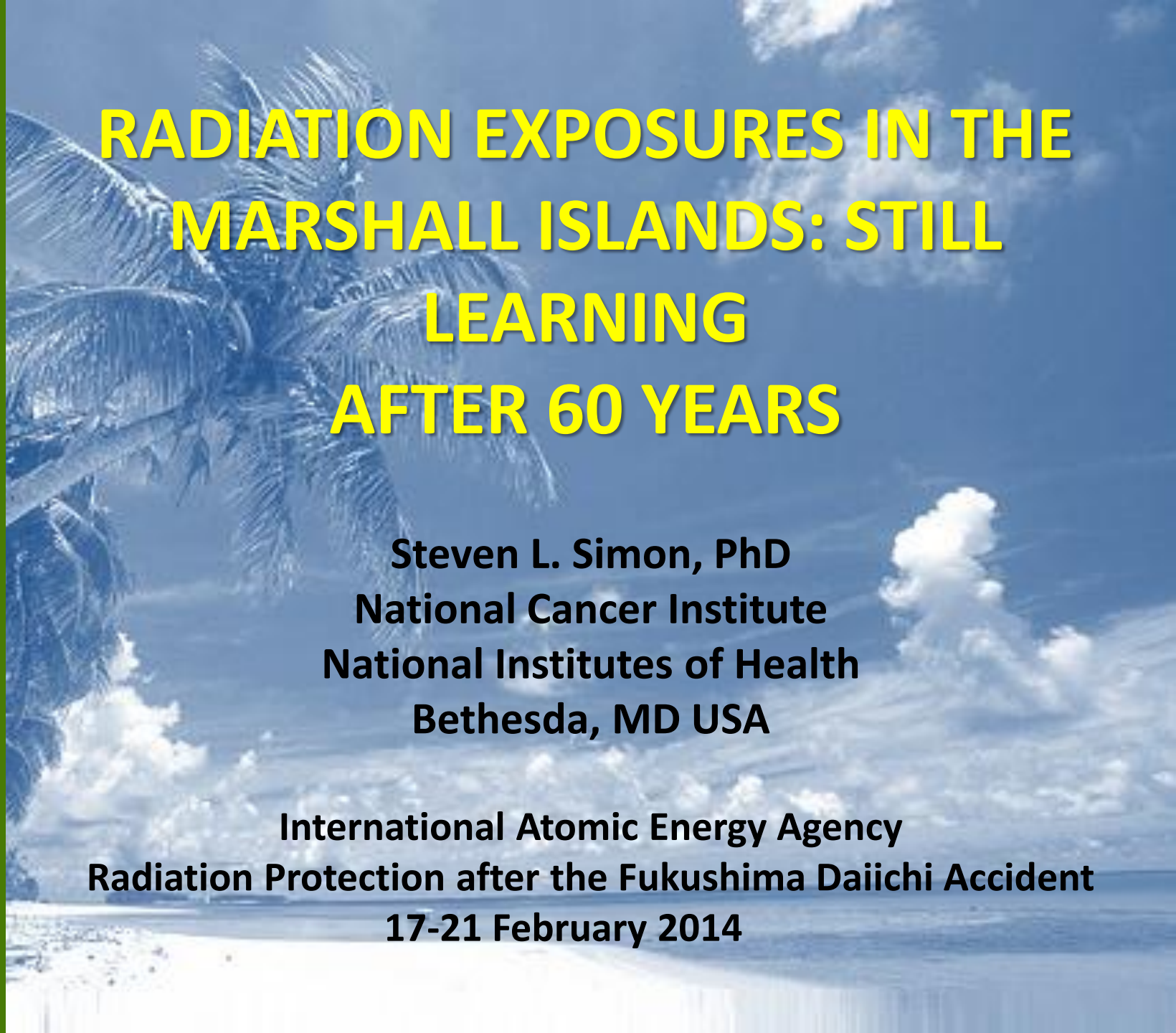

National Cancer Institute

RADIATION EXPOSURES IN THE MARSHALL ISLANDS: STILL LEARNING AFTER 60 YEARS

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health

Purpose of this presentation

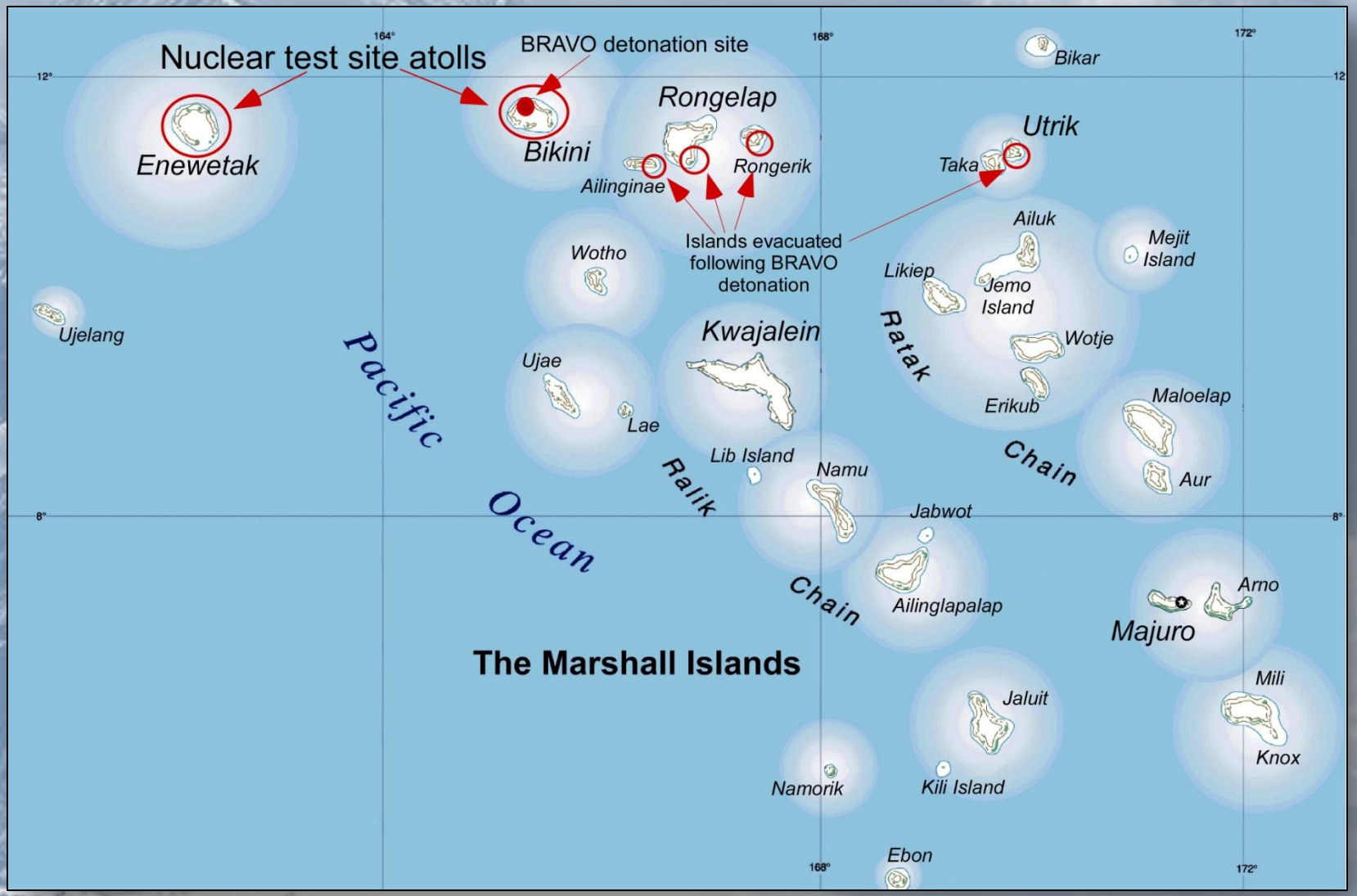
Briefly summarize the exposures that took place in the Marshall Islands from nuclear testing and identify and summarize 5 lessons learned over 60 years.

Note: Any opinions presented here are my own and not necessarily those of the National Institutes of Health.

Background

- Nuclear testing was conducted by the U.S. in the Marshall Islands over 12 years, from 1946 through 1958 and included 66 open air and underwater nuclear detonations.
- Total explosive yield of the program was about 100 Mt (equiv. TNT) and a fission yield of about 50 Mt.
- Activity of I-131 released was ~150 times that of the Chernobyl accident and ~1,500 times that of the Fukushima accident.
- In 1954, radioactive fallout from detonation of a thermonuclear device (code-named BRAVO) on Bikini Atoll heavily exposed nearby atoll populations on Rongelap, Ailinginae, and to a lesser extent, Utrik, as well as U.S. servicemen on Rongerik and the Japanese fishermen on the *Lucky Dragon*.
- Emergency evacuations were conducted of all 4 atoll groups.

Background (con't.)



Background (con't.)

- Exposures of nearby populations (~250 persons) to radioactive fallout resulted in nausea, vomiting and some skin beta burns associated with large external doses (up to 1.9 Gy).
- In high exposure group, large internal doses were received to thyroid gland (up to 20 Gy) and colon (up to 8.5 Gy). Doses to the remaining 12,000 persons were much lower by 10x-100x.
- Radiation-induced thyroid nodules and thyroid cancer were observed in the high exposure group beginning within 9 years.
- Enewetak and Rongelap populations were repatriated but evacuated a 2nd time (years later) because residual contamination of the food chain with long-lived isotopes (primarily Cs-137) led to unacceptable human body burdens. The Bikini population never returned to their homeland due to ongoing fears.

Background (con't.)

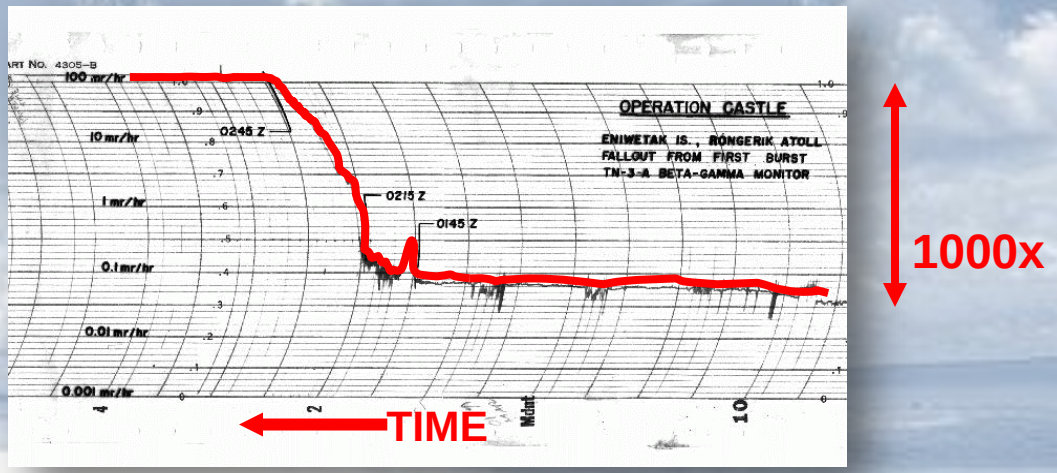
- The Marshall Islands became an independent nation in 1986 and compensation for nuclear testing damages was provided by the U.S. through international agreements.
- In years following the treaty, the Marshall Islands made substantial additional claims for damages and unsuccessfully sought additional compensation for years in U.S. courts.
- The first comprehensive nationwide radiological monitoring program was completed in 1995, confirming measurements made years earlier at the northern atolls but adding new information on much lower contamination levels at southern atolls.
- The IAEA confirmed all measurements independently in 1998.

Background (con't.)

- **The first comprehensive dose assessment for the entire nation was published in 2010 confirming that only the northern atolls received high exposures. Lower radiation doses (by 100x) with lower rates of radiogenic disease were predicted at the distant, southern atolls.**
- **Some limited islands in the test site atolls (Bikini and Enewetak) and northern Rongelap remain at contamination levels beyond those considered acceptable.**

Lesson 1: Identifying who is exposed

- Recognition of who might be exposed during an accident should primarily be a result of real-time data from live radiological monitoring instruments rather than from subsequent radiological monitoring.
- In the case of the Marshall Islands, a single real-time monitoring instrument in 1954 (on Rongerik atoll) triggered the recognition that unexpected fallout of radioactive debris was impacting populated areas.



Lesson 1: Identifying who is exposed

- At later times, the degree of external and internal exposure can be quantified by radiochemical urinalysis, whole body-counting, or estimated from environmental radiation measurements.

- <u>Lesson learned</u>: Real-time monitoring allows for real-time decisions about exposed groups and much earlier evacuations or other remediations. Other measurement-based methods are useful at later times to quantify group or individual exposure.

Lesson 2: Problems of evacuations and repatriations

- Two populations (Enewetak and Bikini) were removed from their islands prior to nuclear testing in 1946.
- Three atoll populations (Rongelap / Ailinginae /Rongerik) were evacuated under emergency conditions in 1954 within about 48 hours after deposition of fallout. Utrik was also evacuated, though with less urgency.

Lesson 2: Problems of evacuations and repatriations

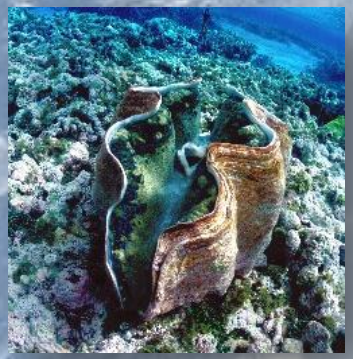
- **The Marshall Islands populations that were removed or evacuated (except for Utrik) have never been fully repatriated despite many attempts over several decades.**
- **<u>Lesson learned</u>: Repatriation of populations living away from traditional places of residence for many years may not be a simple or quick process. There may be considerable attrition of the evacuated group before they believe that it is safe to resettle.**

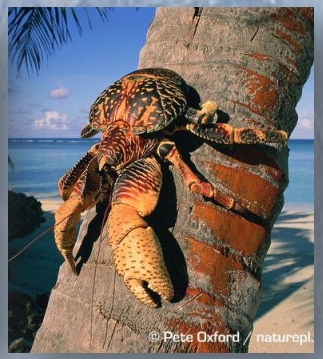
Lesson 3: Understanding the requirements of dose assessment for a non-traditional population

- A crude dose assessment is usually needed immediately after the exposure occurs, in order to determine the level of care needed. A more detailed assessment may be needed years after the exposure in order to quantify the radiation risks or to project future (and long-term) health consequences.
- The requirements of dose estimation for non-traditional (indigenous or native) populations require careful study of their unique lifestyle and diet attributes.

Lesson 3: Understanding the requirements of dose assessment for a non-traditional population

<u>Lesson learned</u>: Producing credible internal dose estimates as well as trust with local populations will take an understanding of the lifestyles and diet of those exposed, and understanding those attributes may take considerable effort.



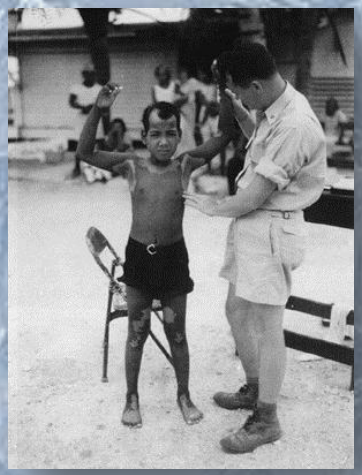


Doses from long-lived nuclides (e.g., Cs-137) can be estimated by the correct input data. In the Marshall Islands, food chains involving aquatic animals and tropical fruits were important. Animal and dairy foods were not.

Lesson 4: Health Risks – Real and perceived

- ***Actual health risks*** **from radiation exposure based on observations or documentation may vary substantially from** ***perceived health risks*** **which often include medical conditions normally not associated with radiation exposure.**
- **Causes of cancer and ill health, other than radiation, are poorly understood by the public.**

Lesson 4: Health Risks – Real and perceived



<u>Lessons learned</u>:

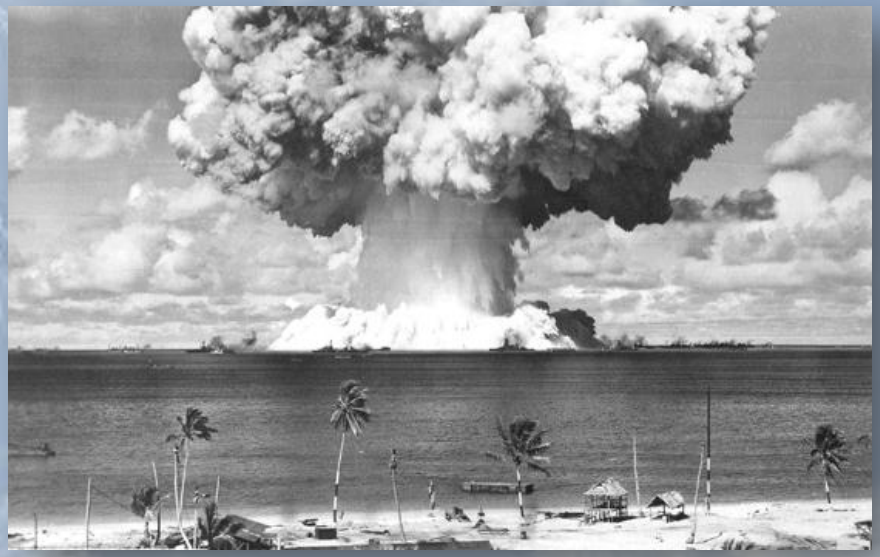
- **Thyroid cancer was a primary outcome of fallout exposure though the baseline (background) rate in the Pacific is also high.**
- **Many other cancer types and ill health conditions are believed to be caused by the exposure, regardless of the degree of evidence.**
- **The determination of future health consequences following exposure is vital to ensuring public health, though the process is fraught with difficulties in communicating and educating the public.**

Lesson 5: Success and failure of monetary compensation programs

- Monetary compensation programs are sometimes used to offset displacements, lifestyle changes and individual burdens, and the occurrence of specific diseases.
- The Marshall Islands experience has indicated that financial compensation is not a panacea and as time goes by, the original financial awards are often judged to be inadequate by those who received it.
- Monetary compensation is also sometimes viewed as a confirmation about harm done, regardless of the degree of actual harm.
- Lesson learned: Long legal struggles can be expected following public exposures despite monetary compensation programs.

Lesson 5: Success and failure of monetary compensation programs

In 1983, the U.S. provided $150 million as a financial settlement for the damages caused by the nuclear testing program. That money was used to create a fund intended to generate $270 million for distribution over a 15-year period. These funds were distributed among the peoples of Bikini, Enewetak, Rongelap, Utrik, for medical and radiological monitoring, and for the payment of individual claims.



Twenty-three years later (in 2006), the Claims Tribunal wrote: "…it has become clear that the original terms of the settlement agreement are…inadequate."

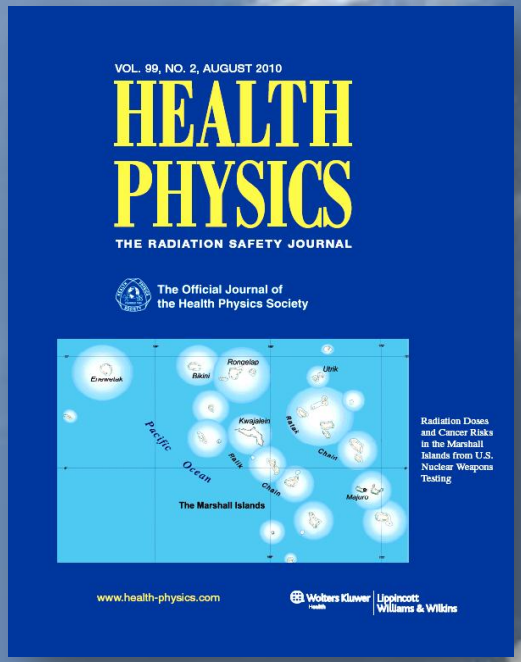
NUCLEAR CLAIMS TRIBUNAL
REPUBLIC OF THE MARSHALL ISLANDS

SUMMARY

- A number of valuable lessons can be deduced from the experiences in the Marshall Islands following nuclear testing.
- The potential for:
  - Substantial public exposures from fallout,
  - Early onset of thyroid disorders,
  - Difficulties with evacuations and repatriations,
  - Lack of success of communication and compensation programs,
  - Distrust of government authorities and scientific experts,

  were all observed in the Marshall Islands, first beginning in the 1950s but extending for many decades.
- 60 years time since nuclear testing ended has not resulted in resolution of all problems associated with exposures of the public.
- Full societal impact often does not depend on the true exposures received.

More information can be found in Health Physics 99(2), 2010.



Thank you for your attention.