INTRODUCTION
Griffith University was formally founded in 1971 without being under the patronage of another University, which had been the case for James Cook University, which commenced with strong links to the University of Queensland. A reason for this decision of government was recognition that the patronage style of development was likely to inhibit innovation in the new institution. The Interim Council, chaired by Sir Theodore Bray, played a vital role by accepting the primary importance of university education as assisting the development of a “liberal mind”. Achievement of this broad goal was to be aided by exposing undergraduates to knowledge across the “Two Cultures” described by C.P. Snow (1959). This concept challenged the common philosophy and organisation of Australian and British universities at the time.

The initial Griffith approach, as described by Topley and Willett (1976), (Willett being the initial Vice-Chancellor), was to design its primary educational units to address a set of problems or issues that are perceived to exist in the world external to universities. The expectation was that this outward-looking focus would result in interdisciplinary “schools”, in which staff and students would focus on “real-world” complexities. This objective was supported by the initial appointment of Professors Rose (as Chairman of Australian Environmental Studies) and Brownlea, both of whom had complementary interdisciplinary problem-oriented experience outside of universities. Providing adequate conceptual and analytical tools to deal with real-world complexities, typified by environmental issues, would of course be expected to require access to knowledge commonly expressed in disciplinary terms.

Griffith opened its doors to teaching in 1975, introducing Australia’s first degree in environmental science. The concept of developing a School, initially named Australian Environmental Studies, to be one of the initial four Schools for the newly-established Griffith University, came from the initiative of Sir Theodore Bray, who was appointed Chairman of the Interim Council of the University in about 1970. Bray’s inspiration came from overseas visits encouraged by members of the Interim Council, in particular Mr John Topley, Secretary to the Council, and later Registrar of Griffith University (Quirke 1996). Bray was impressed by what he saw of developments in environmental concerns in both the USA and Europe, and of environmental studies programs in USA and UK universities (e.g. Sussex University). He had support for his novel idea from at least one Council member, Professor Mason from Macquarie University. Nevertheless the initiative was regarded as a “brave decision” at the time, and was received with scepticism in some quarters.

This brief review will focus on the first five years of the School of Australian Environmental Studies (AES) which has subsequently seen very considerable growth, developing and changing as it must in response to changing issues, understanding, demands and opportunities. We sketch the underlying concepts and structure of the foundation and subsequent years in the Bachelor of Environmental Studies Degree, and provide examples of the research and post-graduate training programs that began to emerge and contribute to the environmental challenges of the times.

CONTEXT, CONCEPTS AND PLANNING
Griffith was planned and began teaching in the 1970s, a decade of unprecedented social and political change. Early documentation developed on the remit for the new environmental School was understandably rather vague, and did not directly address the social and political environmental concerns which were beginning to emerge in Queensland at the time. One concern which attracted international, national and local attention was protection of the Great Barrier Reef from oil exploration and mining (Connell 1971). The actions of two NGOs, the Wildlife Preservation Society and the Queensland Littoral Society, culminated in the initiation of the Royal Commission into Oil Drilling on the Great Barrier Reef, and later the formation of the Australian Institute for Marine Science. A great deal of media attention on the reef and other environmental issues (water pollution, habitat destruction, fish kills,
wildlife conservation) demonstrated that scientific research was lacking and there was limited knowledge regarding environmental management techniques and solutions. Threats to the Reef, and other conservation issues, served to focus public and media attention on environmental management as a scientific matter which needed attention. Most environmental issues of the time required specific research directed towards the Australian environment, since answers were not readily apparent from research elsewhere.

The name ‘Australian’ in the School’s title was seen as a geographical locator and not to be limiting or exclusionary in its range of interests. Environmental Studies at University level was understood as an area of learning, education, research and community engagement involving communication of the knowledge necessary to understand, and hopefully anticipate, the full consequences of human activities which have an impact on the natural world, and through that on the public or common good, such as on human health and wellbeing. Further implications of the term included avoidance of environmental destruction and impact, adopting better management (of natural resources for example), and by innovation, such as the use of renewables and recycling, all in the context of a carbon-constrained world.

The term “Environmental Studies” later became to be used in different ways, for example to describe investigations required before a resource developer, or an industrial firm, could implement an activity deemed to have possible significant impact on the common good. This use of the term is often referred to as ‘environmental impact analysis’, which was expanded in focus to include social impact assessment of development (Lane et al. 2003).

Reflecting the extensive nature of the issues involved, Environmental Studies at Griffith was understood as essentially interdisciplinary. It therefore interacted with, contributed to and drew on the many sciences which are involved in understanding this earth, and its life-sustaining potentiality. The founding scholars were also aware of the vital roles played by socio-economic and policy factors in affecting the role of human activity in modifying and utilizing the resources of this earth-home which we share.

ON INTERDISCIPLINARITY AND ENVIRONMENTAL STUDIES
It is easy to argue that environmental problems have many rather than a single dimension requiring inquiry if we are to understand the issues in any complete manner, with the possibility of improving practice. Certainly dealing with an issue such as climate change, land use and soil erosion, chemical pollution, biodiversity loss, social and economic inequality, or industrial pollution control requires the work of many rather than a single or a few disciplines. The promise of interdisciplinary work is to bring scholars and researchers from diverse disciplines together to focus their theory and research on common problems. According to the Editors of Nature (2015) an interdisciplinary approach should drive people to ask questions and solve problems, especially those that have proved unwilling to yield to conventional approaches.

A university, a research institute or centre committing itself to interdisciplinary study is entrusting itself to build and institutionally embed a “culture of interdisciplinarity”. If accepted by any group or organization, then social and professional relations among individuals across disciplines are frequent and routine rather than exceptional, increasingly easy and enjoyable, and intellectually fruitful. Whilst personal relationships are always important in collaborative work, they can be difficult to establish and sustain in interdisciplinary contexts unless partners exercise considerable empathy, patience, and interpersonal trust. Ease of contact is also important since unless collaborators are in close proximity to each other, fostering the discussions needed to establish interdisciplinary relations is hindered.

In common with the other three initial Schools on which Griffith was founded, the School of Australian Environmental Studies had a considerable degree of autonomy with respect to budget distribution, appointment and promotion of staff, research relationships and curriculum development. Sometimes referred to as a “lifeboat model” (Braddock et al. 1994), this form of organisation was consistent with the University’s desire at the time to promote the study of issues of concern to society, which are necessarily interdisciplinary in nature.

Whilst this School system was conducive to interdisciplinary activity, interdisciplinary teaching and research was not at all common when the University was founded (Ledford 2015), and this may have contributed to a degree of initial suspicion of the School and University in some public and institutional
quaters. In recent years principles conducive to interdisciplinary research are beginning to emerge more clearly (Brown et al. 2015).

Especially during the early growth of the School, developing quite new and innovative teaching programmes was obviously a priority. Whether or not such teaching contributions were adequately recognised in a promotions policy which also included research and community/university service was a cause of some contention.

**BACHELOR OF ENVIRONMENTAL STUDIES DEGREE**

In the founding years of the School there was awareness of necessary interactions of environmental studies with many sciences, the focus being on the following:

- The physical and chemical sciences
- The biological and ecological sciences
- The land use sciences and their interactions with soil science, soil and water conservation, agriculture, and ecosystems
- The social sciences including anthropology, economics and sociology, focussing on the society/environment relationships.
- The interaction of all the above with human health, and
- Last but not least, the applicable mathematical sciences with their vital contributions to mathematical modelling and statistics

The first year of the undergraduate program, which was called the Foundation Year, had two broad objectives.

Perhaps the major objective was to engage students in an exciting, expansive but coherent understanding of the world and its societies from an environmental perspective. Starting with plate tectonics, how can we reach some understanding of the changing earth surface, its development of soil and vegetation and the life forms it sustains under the great variety of climatic regimes. What characterises the web of relationships or ecology of the vast variety of life forms, and how have humans used, selected and modified them? Also how have humans utilised and transformed the earth’s offerings into resources, then how have these complex processes been influenced by social organisation and human culture? Gaining some understanding of Aboriginal culture led a student to say “This is the first time I realised I too had a culture!” How then are resources developed and shared, and what are the achievements and limitations of economic and social systems in such distributional aspects of human life?

Importantly, the development of such concepts and understandings ensured that all students experienced something of the variety of ‘areas of concentration’ available to them in later years, so enabling them to make informed choices in foecussing on those areas they found they enjoyed and wished to pursue.

The second objective of the Foundation Year was to provide knowledge and skill sets basic to later course development, and to employment. A Self-Pacing in Mathematics or SPIM course achieved what the available advice said was quite impossible - namely to take students in one year from any entry level of competence in mathematics to a mastery of basic calculus. Most importantly, mathematical and statistical modelling was applied to understanding environmental systems. Such skills led to highly sought-after students. With teaching commencing at Griffith in 1975, an introduction to computers and computing was obviously also essential.

Another skill-based activity was a practical laboratory program including a Self-Pacing in Chemistry course - both activities being successful only because they were self-pacing in nature.

A most original orientation program, involving first year students and staff, was instituted at the commencement of teaching in 1975, and continued until 1987, when larger student numbers made this off-campus exercise impractical. Staff and students were housed communally at Tallebudgera Fitness Camp on the Gold Coast, participating in seven different local environmental investigations over several days. This proved to be a great learning experience and bonding activity.

This thumbnail sketch may help in catching the flavour of the dimensions of Foundation Year.

The areas of concentration in the second and third years of the three-year bachelor degree program recognised that successful employment of graduates required some recognisable focus of development in knowledge and skills. These areas of concentration are now briefly described.
PHYSICS/SOILS/MATHS AREAS OF CONCENTRATION

Environmental issues are essentially diverse, but commonly include consideration of this earth with its soil, its resources, its water and its atmosphere. Such issues range from local stream pollution to questions of global warming involving enrichment of the earth’s atmosphere by carbon dioxide and other greenhouse gases.

The “areas of concentration” offered in the second and third years of the Bachelor of Environmental Studies program included Environmental Physics, courses in the Soil and Water Sciences involved in sustainable land management and pollution reduction, together with Mathematical and Statistical modelling. Close integration between all these courses and the application of mathematical methods was an important and strengthening feature. Field activities and laboratory programs were an important component developing experimental and data analysis skills. These courses were designed to share the basic physical knowledge required to understand the processes involved in the sustainable use and management of the earth’s land and water systems, and the essential environmental services which they provide. Mathematical modelling was an essential component in interpreting the processes in such systems, but modelling is also recognised as playing a role quite generally throughout all sciences.

Environmental Physics describes the area of knowledge which supports an understanding of all physical processes such as soil erosion, the movement of water and pollutants over and within soil and water bodies. In turn, knowledge of processes provides the basis for designing or evaluating alternative management practices which are more compatible with sustainable land use and healthy and productive waterways and oceans. Physical process knowledge is also involved in understanding earth-atmosphere interactions such as evaporation, photosynthesis and heat exchange.

A strong role in the teaching of mathematics was in supporting systems modelling of all kinds, including analytical and statistical methods. Such methods greatly aid in understanding processes and predicting the consequences of human activities.

When teaching began in 1975, environmental chemistry was a nascent area of science. Although the first-year self-pacing program in chemistry mentioned earlier met the need to recognise chemistry as a fundamental component of any science-related program, later-course teaching in environmental chemistry was dependent on developments in research in that area. This development initially built on analytical chemical studies of pesticide residues, and study of the pathways and implications of such pesticide residues was greatly assisted by new modelling developments in predicting the fate of chemicals moving between different environmental components.

Such advances helped develop research in the School on the bioaccumulation of pesticides, and their adverse effects on aquatic organisms and the natural environment. This research soon led on to study the human health effects of chemical exposure, and the development of risk assessment methods to set exposure guidelines, both for the human and natural environment.

The research outlined above played a major role in supporting the development of post-first year courses in this concentration area. Broader community and public health issues also received attention in research and teaching, linking environmental chemistry with the implicit social and public policy issues involved in responding to its findings.

BIOLOGICAL AND ECOLOGICAL SCIENCES AREA OF CONCENTRATION

Students interested in the ecological sciences and the principles underlying natural and human-affected ecosystems were required to take a basic course in ‘Environmental Biology’ to bring them up to a common skills level, following the model of the SPIC and SPIM courses undertaken in the Foundation Year. The biology course provided field collection and laboratory experience of plant, invertebrate and vertebrate diversity, and the basic biological and physiological knowledge to support the ecological courses of subsequent years. Courses in Natural, Agricultural and Aquatic Ecosystems followed and could be combined with selections from the Physics/Soils/Maths and Chemistry areas. Students were also offered the option of doing a Special Topic, a study program tailored to the special interests of the individual, and ranging across many fields. Naturally
Special Topics were very popular with the students and generated some rewarding outcomes. Fieldwork was a strong component in the early years of the ecology area of concentration, with trips to North Stradbroke Island, Binna Burra (Lamington National Park) and rural locations to experience conservation and management problems first hand.

SOCIAL SCIENCES AREA OF CONCENTRATION

Society and nature relationships were established as a major area of study in the environment school, and a Foundation Chair in the Social Sciences was established. After that, other staff were appointed across the disciplines of anthropology, economics, policy or political science, social geography and sociology. It was a diverse group but one that was generally coordinated around issues of land and water conservation, social and environmental impacts of development, environment and health, Indigenous culture and traditional rights to land. These interests continue with increasing emphasis on issues of environmental sustainability, climate change and energy, animal and human interaction in urban, regional and recreational areas, community and national responses to large-scale natural disasters such as tsunamis. Research sites concentrated on Australia, but research has taken an important international focus so that Australian environmental issues can be considered in a comparative perspective. Projects included analyses of community relations in the cement industry comparing Switzerland and Queensland sites, the changing structure of agricultural production and what that means for rural communities and land conservation, environmental and population health in China and Vietnam, human responses to Dingo habitats in Australia, and the lessons for Australia from Japanese responses to tsunami disasters. Significantly, these interests bring social science researchers into direct and continuing relationships with biophysical scholars and researchers furthering the understanding and contribution of both groups.

RESEARCH AND POSTGRADUATE TRAINING

A challenge to early appointments in this new environmental school was to select staff whose interests and achievements helped cover the wide curriculum range adopted. Development of research programs and linked postgraduate training began almost immediately across the concentration areas, and through interdisciplinary projects. Interestingly, PhD candidates were the first students taken into the School, and one of the first to graduate became the VC of Queensland University of Technology.

An early research project was focussed on the contemporary issue of excessive soil erosion on agricultural lands in the Darling Downs of South East Queensland. Referring to the typical black soils of the region the newspaper headlines read: “The Downs Bled Black Blood”. The project included a study of the socio-economic factors affecting adoption of soil conserving practices (Earle et al. 1979), and evaluation of the spatial patterns of net erosion and deposition using soil coring and Cs-147 tracer techniques (McCallan et al. 1980), illustrating the interdisciplinary nature of research in the School. This is one of the School’s areas where there was strong interaction and collaboration between soil scientists, terrestrial ecologists and environmental sociologists. A research and teaching program on farmer responses to soil erosion, adoption of conservation methods and studies in the structure of agriculture production was developed (Rickson et al. 1987).

Understanding soil erosion and deposition process, and application of this knowledge using mathematical models at a range of spatial scales has been an important research contribution from the School. In the training of a significant number of local and overseas PhD students, the Griffith University Tilting flume Simulated Rainfall facility (or GUTSR) has been vital, resulting in many publications such as the internationally-used soil erosion model of Hairsine and Rose (1991, 1992).

Contamination of the human and natural environments with toxic chemicals has been a prime area of public concern as well as a topic for environmental research in the School. Post graduate projects covered the occurrence of pesticides and petroleum hydrocarbons in aquatic areas particularly the Great Barrier Reef (Miller and Connell 1980). Later projects involved the use of fugacity modelling to explain the occurrence of chlorohydrocarbon pesticides in the environment, particularly fish, in off-shore Sydney (Mortimer and Connell 1995). This led on to projects on prediction of the environmental properties of chemicals such as toxicity and half-life using Quantitative Structure Activity Relationships (QSARs). Later the need to interpret the biological effects of the chemicals in the environment became a focus of postgraduate student research (Hau et al. 2000).
A challenging environmental inquiry of the mid-1970s involved threats from sand mining to the unique features and biodiversity of Fraser Island, the world’s largest sand island. Dr Peter Stevens stepped aside from teaching in AES to serve on the Fraser Island Inquiry (1976), which stopped the sale of mineral sands, and thus sand mining, so contributing to protection of the island as a UNESCO World Heritage site in 1992. Research on the geomorphology, biodiversity and sensitivity of freshwater dune lakes provided vital evidence to the inquiry and the World Heritage nomination (Arthington 1977; Arthington and Watson 1982). Discovery of new freshwater species endemic to sand dune lakes and wetlands supported this nomination and the declaration of Moreton Island as a National Park. More recently, a Griffith PhD candidate studied the impacts of recreation and tourism on Fraser Island’s dune lakes and went on to become an expert on the implications of tourism and climate change for coastal ecosystems (Hadwen and Arthington 2003, 2011).

CONCLUSIONS
This brief account describes the interdisciplinary environmental studies program implemented in the foundation years of Griffith University, but let us remember that universities have a long and proper history of devotion to disciplinary education and research. Thus, as an essentially interdisciplinary area of study and activity, environmental studies can be a somewhat contested area, subject to possible suspicion and misunderstanding. There are pressures on it to conform to a disciplinary framework, such as ecology, geomorphology or policy and economics, such conformity assisting its ready acceptance as a recognisable science, and so assuring its “respectability” in the general University world.

The philosophical foundations of Griffith’s interdisciplinary teaching, research and post-graduate training in the environmental sciences have stood the test of time as reviewed by Metcalf et al.(1996), with graduates from the Bachelors program being employed nationally and internationally in many spheres. The research programs of those early years have mutated and blossomed into respected research consortia and institutes that continue to address and inform contemporary challenges, such as sustainable land management, cities and regional areas, environmental health, chemical impact risk analysis, biodiversity conservation, the management of rivers and wetlands, urban planning, and environmental futures.

LITERATURE CITED


HAIRSINE, P.B., and ROSE, C.W. 1992. Modelling water erosion due to overland flow...

AUTHOR PROFILES
Calvin Rose is an Emeritus Professor with the Griffith School of Environment, where he was inaugural Dean in 1973-1978. Having been invested as a Life Member of the Royal Society of Queensland in 2016, Calvin continues research with colleagues in the School’s Australian Rivers Institute. In this he draws upon long experience in soil science and environmental physics in modelling land and water degradation processes.

Angela Arthington is an Emeritus Professor in the Australian Rivers Institute, Griffith University, where she established the first freshwater research centre in 1997. Angela continues research on the ecology and management of rivers with emphasis on maintaining environmental flows for fish and protecting river integrity generally. She serves on the Council of the Royal Society, on several journal editorial boards and supports the research of many colleagues at Griffith and internationally.

Des Connell is an Emeritus Professor with the Griffith School of Environment where he was Dean of the School following Calvin Rose as Inaugural Dean. He was made a Member of the Order of Australia and awarded a Doctor of Science degree for his research on the behaviour and effects of chemicals in the environment. His research is currently directed towards the assessment of the health and ecotoxicological risk of chemicals in the natural and the occupational environment using probabilistic techniques.

Emeritus Professor Roy E. Rickson is a member of the Griffith School of Environment and the Environmental Futures Research Institute at Griffith University. His research is in the areas of environmental sociology and the sociology of agriculture focusing on changes in the structure of agricultural production, land degradation processes and farmer responses as well as tensions between natural resource development on rural lands and farming communities. Current writing is on industry and rural community relationships in mining developments comparing Switzerland and Australia.