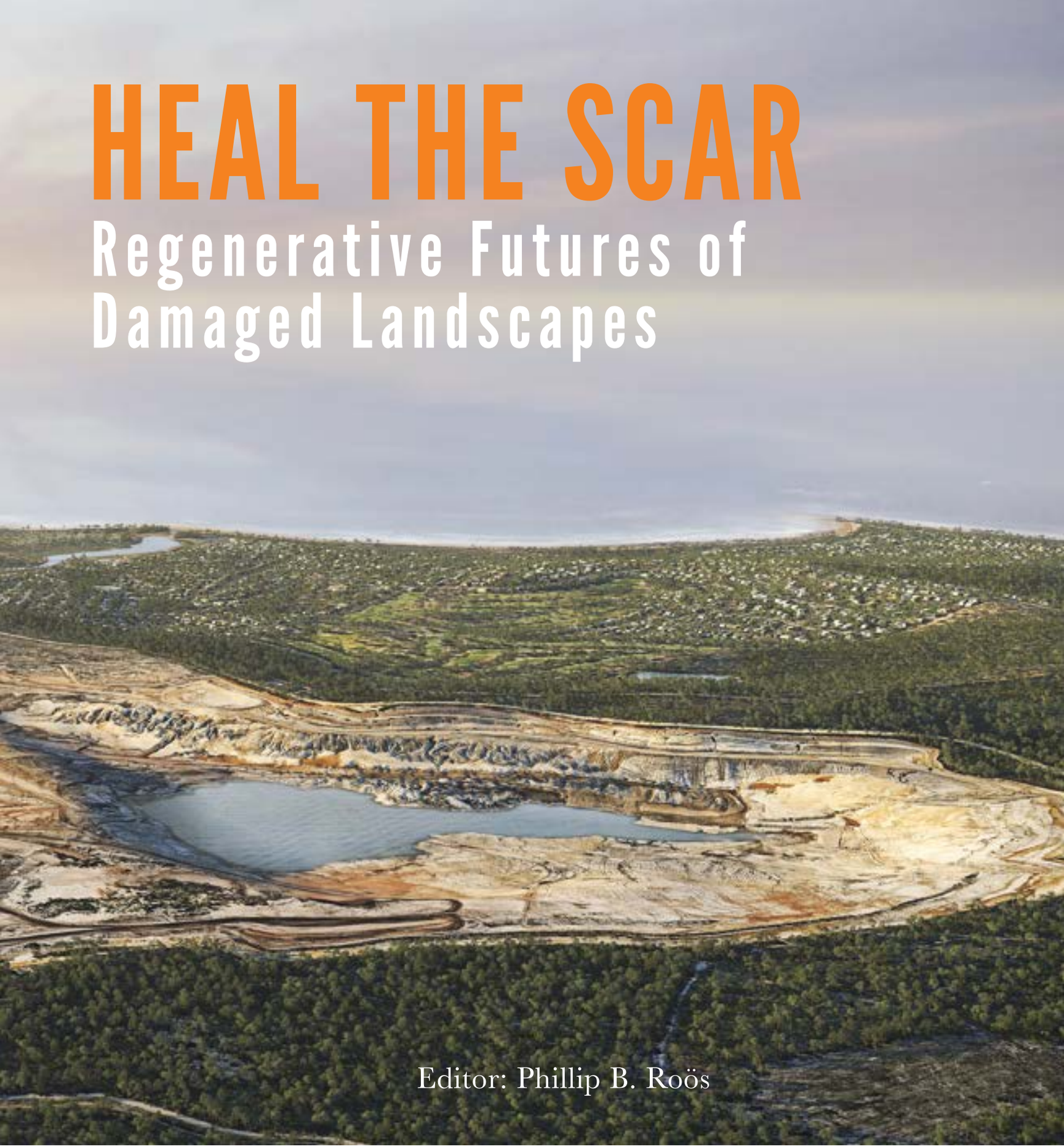
HEAL THE SCAR

Regenerative Futures of Damaged Landscapes



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LIVE+SMART Research Laboratory

Heal the Scar offers an insightful investigation and visionary concepts for the re-purposing and regeneration of exhausted quarry and mine sites. Commencing with framing the global problem of a rapidly expanding non-renewable resource extraction industry to supply the cheap resource needs for a rapidly urbanised world, chapters progress to explore alternative solutions towards more sustainable and environmentally focused options that address the negative legacy and impacts upon the lands and waters that these mine sites leave behind. This book seeks to discuss current issues relating to these scars in the landscape, the closed, rehabilitated and/or abandoned mine sites; especially those sites that are next to human settlements. So how can these sites be transformed from highly environmental impacted and damaged landscapes to sustainable and regenerative places that respect and engage with their environments and their surrounding communities. The research team and contributing authors attempt to provide insights to help answer one important question - What can we do to solve this problem?

Expert contributions informed an interdisciplinary approach that was adopted for the *Heal the Scar* project. This approach aided the development of a theoretical model to potentially enhance community wellbeing through an economically feasible solution for the regeneration of exhausted quarry and mine sites. Based upon the use of an 'Integral Design Framework' (IDF), and a 'Regenerative-Adaptive Design Model', scenario modelling informed visionary hypothetical concepts and propositions for the chosen pilot study site, in this instance the former Alcoa mine site in Anglesea, Victoria.

"To be fair, in this industrial era, most humans have been relatively unconscious of the cultural and environmental impacts of these grand-scale actions and mass-produced artefacts. Today we know better, and as architect William McDonough says, 'Now that you know, responsibility starts tomorrow.' Such partial culpability belongs with anyone who has ever flown in an airplane, drank a beverage from a can, owned a laptop computer, or even plugged into the electric grid. The Heal the Scar project is the enactment of taking that responsibility … With the humility brought on by hindsight about international corporate thinking informed by the best science and engineering of its day, the project team takes a meta-view of this forbidding problem. The approach is both practical and visionary. The answer lies with some leading-edge thought models ... It is deep work to think about big, thorny, seemingly unsolvable problems." – Professor Mark DeKay & Susanne Bennett, of the University of Tennessee at Knoxville, and authors of Integral Sustainable Design - Transformative Perspectives (2011)." – Professor Mark DeKay & Susanne Bennett, of the University of Tennessee at Knoxville, and authors of Integral Sustainable Design – Transformative Perspectives (2011).

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The Live+Smart Research Laboratory and School of Architecture & Built Environment, Deakin University acknowledges the Traditional Owners of the lands and waters that we live and work on across Australia and pays its respect to Elders past and present. We also recognise that Aboriginal and Torres Strait Islander peoples have made and will continue to make extraordinary contributions to all aspects of Australian life including culture, economy and science.

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HEAL THE SCAR

An integral approach to regenerating exhausted quarry and mine sites, and holistically enriching both the site and its surrounding community

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Acknowledgement of Country

The Authors, the Live+Smart Research Laboratory and the School of Architecture & Built Environment Deakin University acknowledge and pay their respect to the Wadawurrung peoples and their Elders, past and present, and the rich cultural and intrinsic connection they have to their Country. We also recognise and acknowledge the contribution and interest of other Aboriginal peoples and organisations in the management of lands, waters and natural resources in this region.

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Indigenous readers should note that the content of this book might include names of deceased persons. No offence is meant to any relatives of the deceased. The majority of the material in this book has been sourced from public domain publications, and previous published works.

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The representation of development scenarios are hypotheticals, 'what if' and visionary representations, and do not represent actual current conditions or predictions of the future of the Anglesea coal mine site or the surrounding Anglesea landscape. These illustrations do not carry any endorsement (including the accuracy of the proposed scenarios) by the authors, the publisher, Deakin University, or any organisations, corporation, community group or persons affiliated with the authors, publisher or Deakin University. To the extent permitted by law the authors and Deakin excludes liability for any and all loss caused by use of or reliance on this information in this publication.

This research, entitled '*Heal the Scar*', is subject to an approved Cultural Heritage Permit WAC-P0031 issued by the Wathaurung Aboriginal Corporation [now Wadawurrung Traditional Owners Aboriginal Corporation] in accordance with s.36(1) of the Victorian Aboriginal Heritage Act 2006 dated 28 August 2019.

In the event of further evaluation and planning work and potential development on the Anglesea site, it is recommended that prior informed consultation with the Wadawurrung Traditional Owners Aboriginal Corporation be a requirement.

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Tim Tutt

Figure 10.1 Water body in process of remediation (Roös 2019)

A scar covered by water is still a scar. The Anglesea coal mine pit is substantially below sea level and is modelled to fill with water over the next 20 years (Alcoa 2018a). While the pit fills with water, it will be affected by acid mine drainage. Sulphide minerals such as pyrite (FeS2) in mined and unmined coal, are oxidised by air and water producing sulphuric acid;

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O \rightarrow Fe(OH)_3 + 2\ H_2SO_4$$

As the pit's water quality may not meet guidelines for uses such as swimming and sailing, current closure and consultation documents deliberately refer to the filling pit as a "water body" rather than a "lake" and indicate a decision about how it can be used is probably 10 years away (Alcoa 2018b). The term "water body" aims to supress aspirations for its use and follows conservative approaches to describing unremediated mine water bodies. Nearby however, a mildly acidic coal mine water body (privately owned) has been used for decades for swimming, water-skiing etc., with much benefit and enjoyment to its owners and their friends, could this not be the case for Anglesea? Ultimately the water body may be a "lake" given enough time (multiple decades) or initiatives both technical and regulatory (i.e. guideline revisions) could create a "lake" much sooner.

Wensleydale open cut coal mine, ceased operation in the 1960s, is 18 km north-west from Anglesea and is now, fortuitously, a water body. Tutt's (2008) study of Wensleydale drew insights into what features and process have shaped its evolution. It is still pH 5 and ecologically impoverished after 40 years. Mine shape, water body connectivity, water quality (acidity, nutrient deficiency) and limited primary production, combine to slow recovery and rehabilitation. Unsurprisingly, countering these factors will increase the rate of rehabilitation.

Tutt, T (2020), Aquatic Healing: From a Liability to a Lake. In: PB Roös (ed.) (2020), *Heal the Scar: Regenerative Futures of Damaged Landscapes*, pp. 35-36. Geelong, Vic: The Live+Smart Research Lab, Deakin University. ISBN: 978-0-7300-0160-7 (pbk) / ISBN: 978-0-7300-0292-5 (epdf)

To address water quality bioremediation using anaerobic sulphate reducing bacteria (SRB) was suggested as early as 1969 by Tuttle et al., (1969). Numerous studies have been completed since, including an in situ mesocosm bioremediation trial at Wensleydale by myself. At Wensleydale an organic substrate was added to 4 out 6 water filled mesocosms (i.e. 2 controls) and monitored over 12 months. Deep water bodies undergo an annual thermal stratification process. The lower ("hypolimnion") layer formed in summer creates the anoxic conditions required for the SRB to establish sediment and bioremediate the water, as shown by the simplified equation;

$$2(CH_2O)_{(s/aq)} + SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} \rightarrow 2CO_{2\,(aq)} + H_2S_{\,(aq)} + 2H_2O$$

(where CH2O is a simplified version of organic matter and H+ is acidity that is consumed)

After 12 months mesocosms with doses of 2 g organic matter/L had increased their pH from 5 to over 6. Even the control mesocosms (no substrate added) also recorded an increase in pH at the base of their water column. Filamentous algae colonised walls of the 1.2 m diameter, 16 m deep cylindrical polyethylene mesocosms and over the duration of the experiment a 2mm layer of black organic sediment (algae detritus) had accumulated – sufficient to stimulate SRB activity.

A terrestrial mine rehabilitation typically includes returning topsoil, controlling erosion, and revegetating via seeds or plantings, following which greater ecological recovery is anticipated.

Figure 10.2 Bioremediation using greenwaste sediment (Tutt, from Sherwood, 2005)

Similarly, if an acidic water body is to be rehabilitated actions are required. Creation of an organic substrate (i.e. the "topsoil") either by importing mulched green waste for example, or via primary production in in-situ wetlands, floating wetlands or floating algae curtains, will add organic matter to sediments and enhance SRB bioremediation of acid water. Additionally, creating wetlands is akin to revegetating water and in this action, faster and greater ecological recovery would be anticipated.

Knowledge and experience in large pit lake remediation is limited (Geller et al., 1998), however given the environmental, social and economic benefits a healthy lake can provide, the need is self-evident (McCullough et al., 2006), particularly in a time when more and more coal mines are likely to close. Great opportunity exists for Anglesea to be an exemplar case study showing how to turn an ecologically depauperate acidic pit water body into a healthy lake, and, going even further, the potential of such a project to sequester significant amounts of carbon at the same time.

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Live+Smart Research Laboratory

The Live+Smart Research Laboratory is a multidisciplinary research hub that focuses on key themes of applied research for providing solutions of a rapidly urbanised world. The vision of the Lab is to investigate real problems around one of our global society's biggest issues of the 21st century: rapid urbanisation and the decline of rural areas.

Researchers at the Lab use innovative theoretical models embedded in smart technology, and the School of Architecture and Built Environment's Integral Design Framework (IDF), to explore technology-enabled solutions that can be tailored for either urban and rural communities. The complexity of dynamic design and planning processes is enabled through the use of digital models and application of VR (Virtual Reality) and AR (Augmented Reality) technologies, allowing immersive and interactive spatial visualisations of analysis of data through digital simulations and scenario modelling.

Beyond the day-to-day research activities, the Live+Smart Research Lab builds partnerships with key community, industry and government organisations to deliver innovative solutions. This includes establishing living labs, and developing prototypes and concepts that are grounded in achieving sustainable, innovative, adaptive, and resilient outcomes for the future. The aim of the Lab is to reconnect human habitats with the natural environment towards crafting healthy and regenerative future for both in partnership.

The Live+Smart Research Laboratory was founded by Dr Phillip B Roös in 2018. The Lab is located at the School of Architecture & Built Environment, Deakin University, Geelong, Victoria, Australia.

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