

The up-to-date code to generate this document is always available [here](#).

Why a UWA colour palette generator for R?

Colour palettes with relatively few distinctive colours are often used in the corporate world. Apparently they confer a consistent “look and feel” to company-branded materials, making publications, presentations, and advertising more memorable and the brand more recognisable.

When presenting material clearly from a scientific perspective, however, corporate colour palettes can be problematic if they include colour combinations that are difficult to distinguish for people having colour vision impairments such as red-green colour-blindness. Where colour comparisons are important to interpreting data presented graphically, the contrast between the items being compared should be visible to as many people as possible, regardless of colour-blindness. In addition, the print copies of some scientific journals still reproduce figures as greyscale images, so a colour palette that maintains as much contrast as possible when converted to greyscale is preferable. This is achieved with:

1. a *uniform gradient*, an approximately linear relationship between greyscale value and colour palette index;
2. a wide range of initial contrast (dark to light, or *vice versa*).

The importance of a wide range in contrast when converting to greyscale is illustrated by the four versions of the same map shown in Figure 1 below.

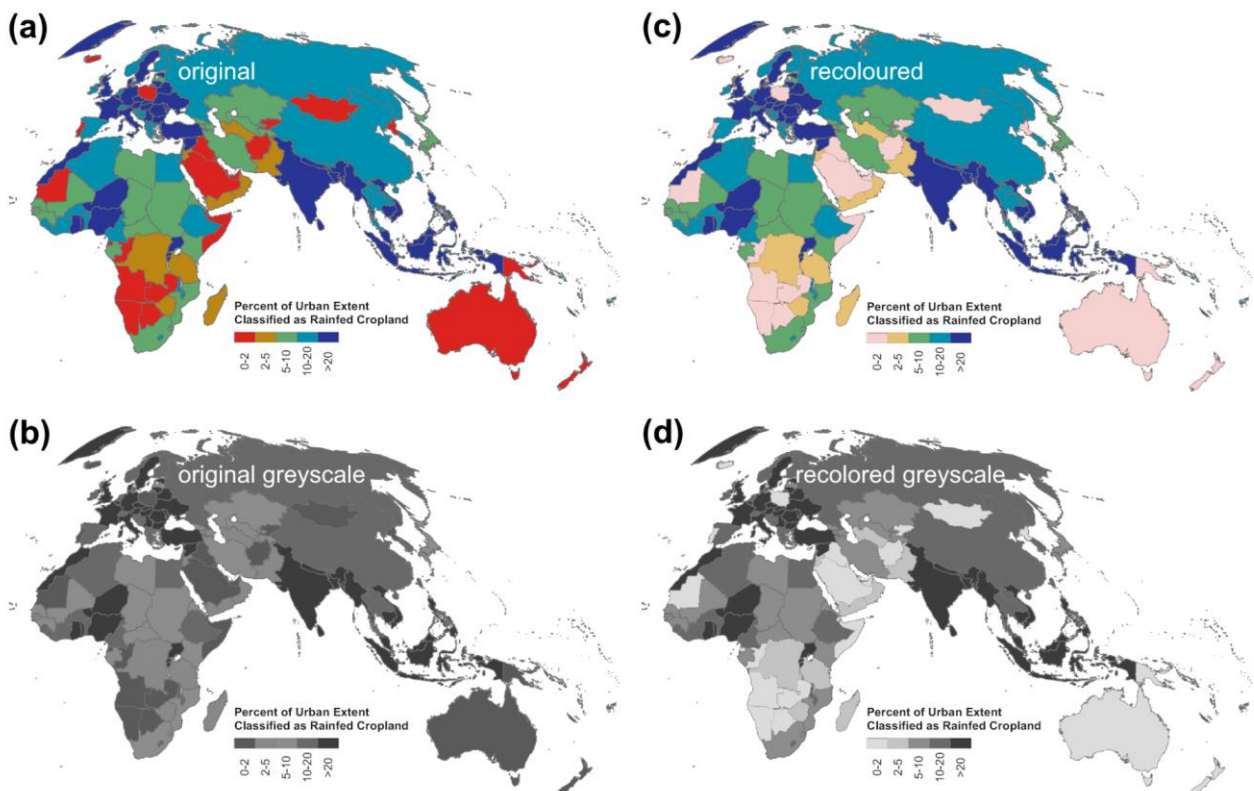


Figure 1: Four versions of the same map: (a) original colours from Thebo *et al.* (2014); (b) original map converted to grayscale; (c) recoloured map used in Rate (2022); (d) recoloured map converted to grayscale. Greyscale conversions were performed in [paint.net](#) (Brewster, 2023).

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Fortunately for staff and students working at UWA, the standard blue and gold colours in the [UWA brand](#) lend themselves well to generation of themed colour palettes which are colourblind-friendly. The development of a possible UWA colour palette with uniform colour gradient is discussed below. I have focused on the creation of this palette in the **R** statistical computing environment (R Core Team, 2022); many people at UWA use **R**, but many don't, so there is some comment on use of the UWA palette in Microsoft Office® software near the end.

1. Existing palettes available in R packages

There are several existing **R** packages and functions which allow generation of uniform-gradient, colourblind-friendly palettes.

1.1 RColorBrewer

The [RColorBrewer](#) package (Neuwirth, 2022) contains 35 in-built palettes, 27 of which are colourblind-friendly (Figure 2). One of these ([YlGnBu](#)) has end-member colors which are near the UWA colours in the colour wheel, but not at the exact hues.

```
library(RColorBrewer)
display.brewer.all(colorblindFriendly = TRUE)
```

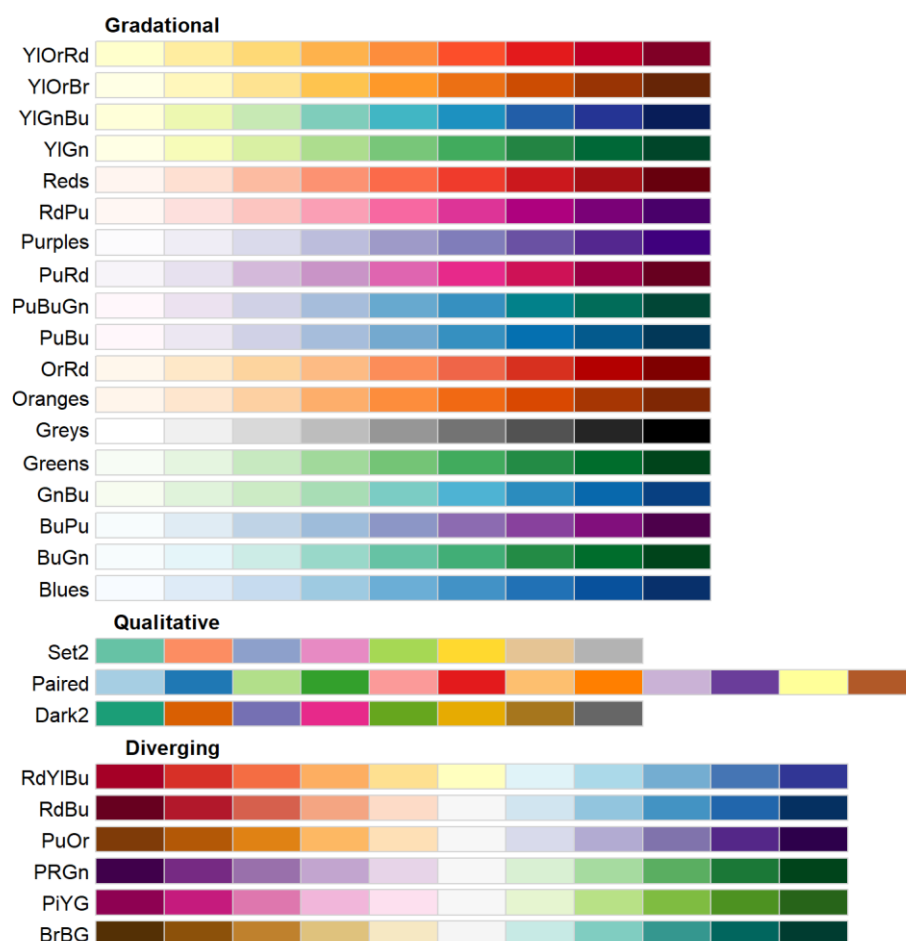


Figure 2: Colourblind-friendly palettes from the [RColorBrewer](#) R package. Each palette is shown with the maximum allowable number of colours.

For comparison, the [RColorBrewer](#) colourblind-friendly palettes viewed in greyscale are shown below (Figure 3:

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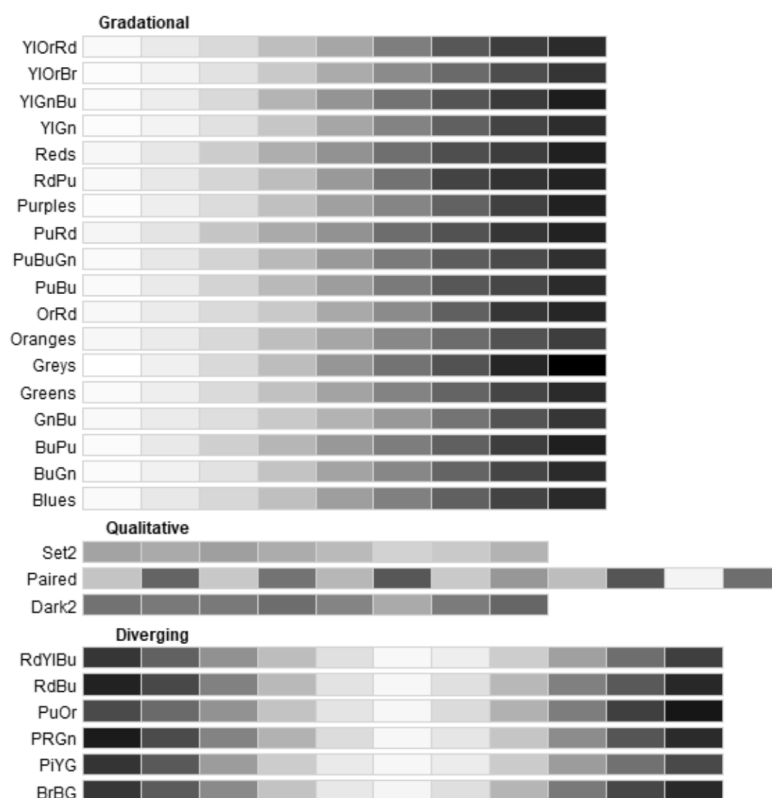


Figure 3: Colourblind-friendly palettes from the [RColorBrewer](#) R package, shown as a greyscale image created using the [imager](#) R package (Barthelme, 2023).

1.2 Viridis

The [viridis](#) and companion [viridisLite](#) R packages (Garnier *et al.* 2021) are specifically designed to address and minimise loss of information caused by colourblindness. The vignette supplied with the [viridis](#) package provides an excellent explanation of the need for, and functions of, the package (in RStudio, run `help(package="viridis")`, then select User guides, package vignettes and other documentation, then select `viridis::intro-to-viridis`). The [viridis](#) package has eight colour palettes which are shown as gradients in Figure 4 below (each palette can be used to generate fewer discrete colours as well). The [cividis](#) palette, a corrected version of the original [viridis](#), appears to contain hues most closely resembling the [UWA brand](#) colours.



Figure 4: The colour palettes available in the [viridis](#) and [viridisLite](#) R packages (Garnier et al. 2021).

1.3 Scico

The final R palette package worth investigating is `scico` (pronounced 'psycho'; Pedersen and Crameri, 2023). The `scico` package can generate 35 different palettes, some of which can be categorical; my favourites are shown in Figure 5 below. None of the built-in colour palettes in the `scico` package are good analogues for the UWA brand colours.

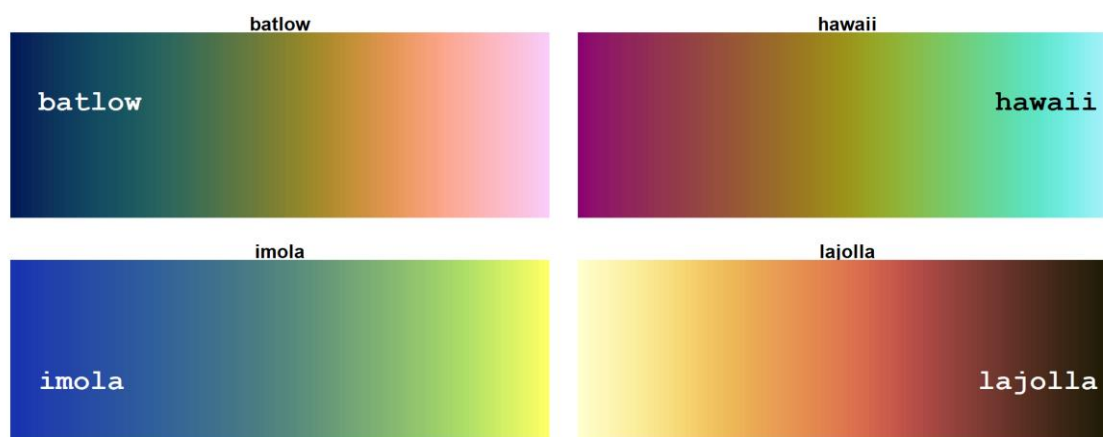


Figure 5: Examples of gradational palettes available in the `scico` package.

2. Development of a draft UWA colour palette for R

From the previous section we saw that several packages in R could generate useful colour palettes with approximately uniform [brightness] gradients. **I would definitely recommend** trying and using uniform-gradient, colorblind-friendly palettes of colours from any of the packages described in Section 1. Using these palettes appropriately would add accessibility to presentations and written teaching materials without sacrificing aesthetic appeal. That none of these palettes perfectly captures the UWA brand should not be any impediment to their use!

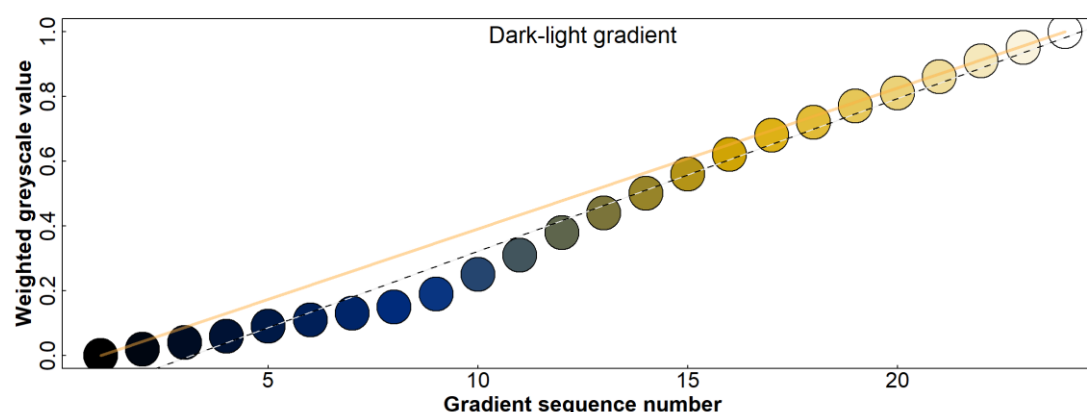
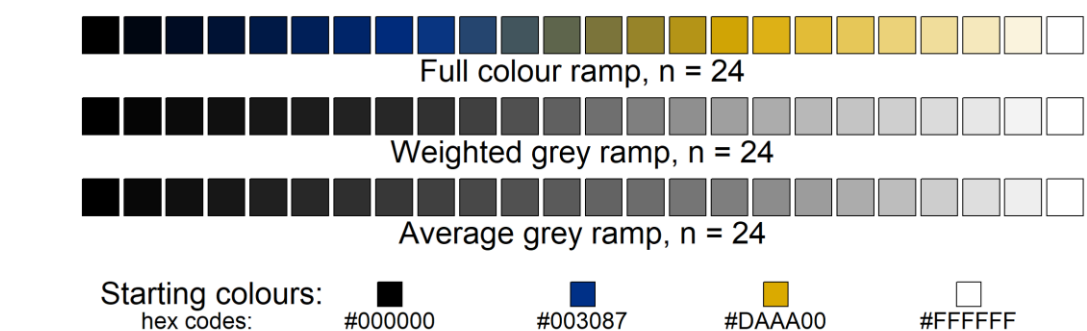


Figure 6: Analysis of initial attempt at a UWA uniform-gradient colour palette.

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To maintain the “look and feel” of the [UWA brand](#), however, we need a colour palette which explicitly includes the brand colours, so the remainder of this document describes the steps in development of one such palette. The simplest and most obvious option was to try a colour gradient with the two core colours of the UWA brand: [UWA blue](#) and [UWA gold](#), bracketed by black and white. A gradient of the desired number of colours was generated using the `colorRampPalette()` function in R. As can be seen in Figure 6 above, this produced an attractive, full-contrast, gradient which was nearly uniform.

The palette in Figure 6 does not have a perfectly uniform gradient, however, so in the interests of personal perfectionism the development process continued. (I also thought that this initial palette did not have enough blue saturation at the ‘dark end’.) By iteratively substituting some of the core colours used to generate the palette with secondary colours from the previous palette(s), including not starting from pure black, it proved possible to generate more uniform palettes (Figure 7):

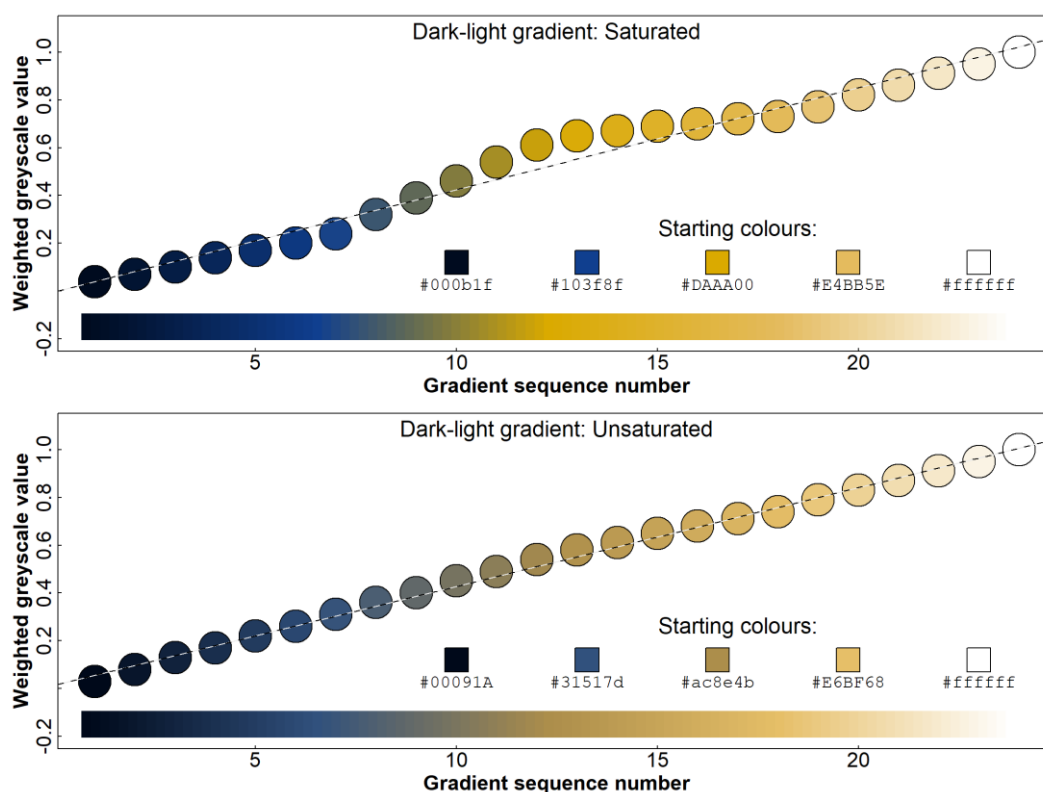


Figure 7: Display and analysis of subsequent attempts at uniform-gradient UWA colour palettes.

For the palettes shown in Figure 7, the full range of contrast (zero to 100%) is not quite achieved, and the saturated version has a slightly non-uniform gradient. Both are probably suitable for most application required of them (the unsaturated version is similar to [cividis](#) from the [viridis](#) R package).

If you want to use these palettes in R, you can download code for a function to generate them [at this link](#). Alternatively, you can run the line of R code below:

```
source("https://github.com/Ratey-AtUWA/Learn-R/raw/main/UWAcograd.R")
```

Explanations of the arguments of this function are given in standard format in [the code file itself](#).

3. Using the UWA colour palette in MS Office

We all use MS Office apps, even though we might not want to admit it. MS Office allows users to change the palette of a document (e.g. Word, PowerPoint, Excel) by selecting Design | Colors | Customize colors. This opens a dialog where we can edit and save a colour palette, entering the RGB or hex colour values available via the [UWA brand](#) (Figure 8).

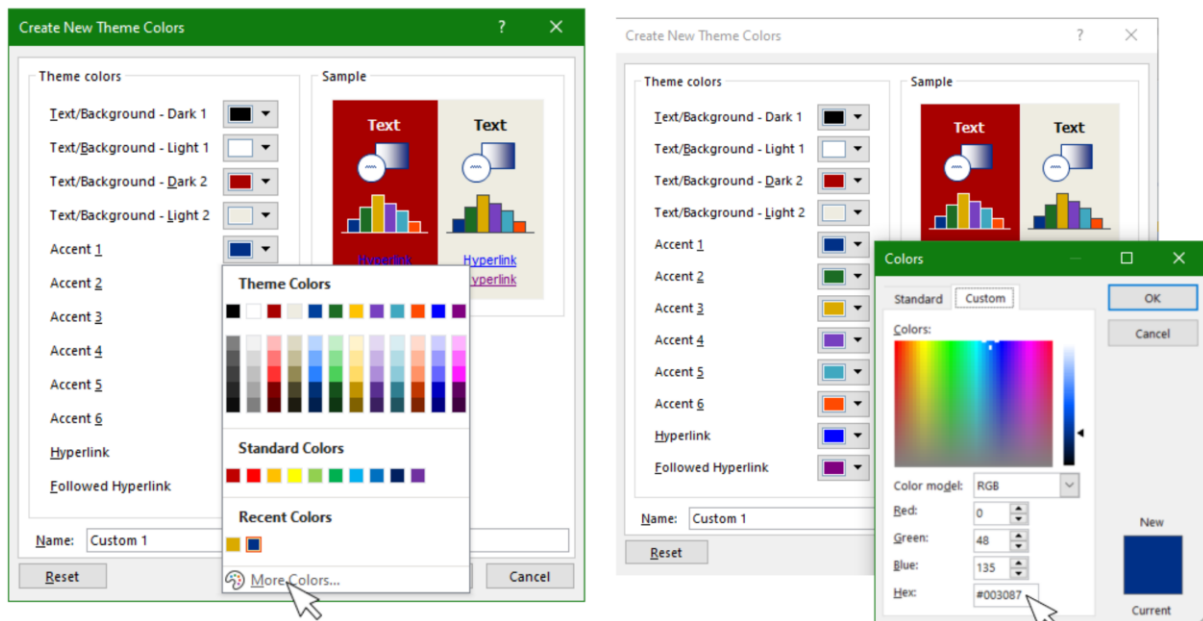


Figure 8: Editing colours in a custom palette (theme colours) in a Microsoft Office app.

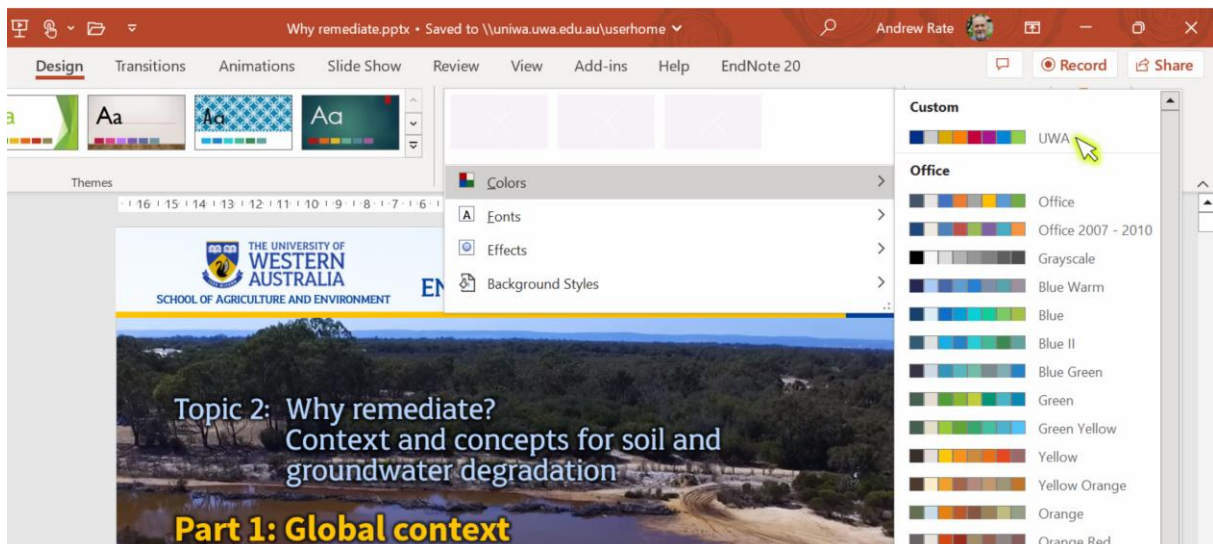


Figure 9: Selecting a custom palette in MS Office software.

The custom palette shown also includes some of the secondary colours in the [UWA brand](#) specification.

References

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