Un modelo NPZD simple para lagos del sur de chile

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1 Introduction

Un modelo biogeoquímico es una representación simplificada y matemática de los procesos biológicos, geológicos y químicos que ocurren en los ecosistemas. Estos modelos se utilizan para comprender y simular los flujos de energía, nutrientes y elementos químicos a través de los sistemas naturales, como los océanos, bosques, suelos y cuerpos de agua. Los modelos biogeoquímicos integran información sobre los ciclos biogeoquímicos, que incluyen procesos como la fotosíntesis, la descomposición, la respiración, la fijación de nitrógeno, la lixiviación de nutrientes y la deposición atmosférica. Estos modelos tienen en cuenta las interacciones entre los diferentes componentes del sistema, como las plantas, los animales, los microorganismos, los suelos y la atmósfera. Los modelos biogeoquímicos son herramientas poderosas para predecir los efectos del cambio ambiental, como el cambio climático, la contaminación y la deforestación, en los ciclos biogeoquímicos y en la salud de los ecosistemas. También se utilizan para evaluar la eficacia de las estrategias de gestión y conservación, y para informar la toma de decisiones en la gestión de recursos naturales. Los modelos biológicos han sido ampliamente utilizados para comprender la dinámica y las interacciones en los ecosistemas pelágicos. Entre ellos, los modelos de compartimentos han sido especialmente relevantes al agrupar poblaciones completas en compartimentos individuales que interactúan entre sí. La complejidad de estos modelos varía en función de las variables de estado incluidas y las reglas que gobiernan su interacción. Un modelo conocido en este contexto es el modelo propuesto por Fasham et al. (1990), el cual incluye siete compartimentos: fitoplancton, zooplancton, bacterias, nitrato, amonio, nitrógeno orgánico disuelto y detritos. Sin embargo, uno de los modelos biológicos más simples y ampliamente utilizado es el modelo NPZ desarrollado por Franks et al. (1986), que considera únicamente tres compartimentos: fitoplancton, zooplancton y nutrientes disueltos. El modelo NPZ captura los procesos fundamentales que rigen el crecimiento y las interacciones entre estos compartimentos clave. Considera variables como la disponibilidad de nutrientes, la presión de pastoreo y las tasas de crecimiento del fitoplancton, brindando una representación simplificada pero valiosa de la dinámica de los ecosistemas pelágicos. Este modelo ha sido adaptado y aplicado en diversos entornos marinos, proporcionando información crucial sobre el funcionamiento de las comunidades planctónicas y sus respuestas a los cambios ambientales. En conclusión, los modelos biológicos, como el modelo NPZ, desempeñan un papel crucial en nuestra comprensión de la compleja dinámica y las interacciones en los ecosistemas pelágicos. Aunque existen modelos más complejos que abarcan múltiples compartimentos y variables, el modelo NPZ proporciona una representación efectiva y simplificada de los componentes esenciales en estos ecosistemas. Estos modelos son herramientas valiosas para avanzar en nuestro conocimiento y contribuir a la conservación y gestión de los hábitats marinos.

Once you're familiar with the editor, you can find various project setting in the Overleaf menu, accessed via the button in the very top left of the editor. To view tutorials, user guides, and further documentation, please visit our help library, or head to our plans page to choose your plan.

2 Some examples to get started

2.1 How to create Sections and Subsections

Simply use the section and subsection commands, as in this example document! With Overleaf, all the formatting and numbering is handled automatically according to the template you've chosen. If

Figure 1: This frog was uploaded via the file-tree menu.

Item	Quantity
Widgets	42
Gadgets	13

Table 1: An example table.

you're using Rich Text mode, you can also create new section and subsections via the buttons in the editor toolbar.

2.2 How to include Figures

First you have to upload the image file from your computer using the upload link in the file-tree menu. Then use the includegraphics command to include it in your document. Use the figure environment and the caption command to add a number and a caption to your figure. See the code for Figure 1 in this section for an example.

Note that your figure will automatically be placed in the most appropriate place for it, given the surrounding text and taking into account other figures or tables that may be close by. You can find out more about adding images to your documents in this help article on including images on Overleaf.

2.3 How to add Tables

Use the table and tabular environments for basic tables — see Table 1, for example. For more information, please see this help article on tables.

2.4 How to add Comments and Track Changes

Comments can be added to your project by highlighting some text and clicking "Add comment" in the top right of the editor pane. To view existing comments, click on the Review menu in the toolbar above. To reply to a comment, click on the Reply button in the lower right corner of the comment. You can close the Review pane by clicking its name on the toolbar when you're done reviewing for the time being.

Track changes are available on all our premium plans, and can be toggled on or off using the option at the top of the Review pane. Track changes allow you to keep track of every change made to the document, along with the person making the change.

2.5 How to add Lists

You can make lists with automatic numbering . . .

1. Like this,

2. and like this.

. . . or bullet points . . .

- Like this,

- and like this.

2.6 How to write Mathematics

LaTeX is great at typesetting mathematics. Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{X_1 + X_2 + \cdots + X_n}{n} = \frac{1}{n} \sum_i^n X_i$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $\mathcal{N}(0, \sigma^2)$.

2.7 How to change the margins and paper size

Usually the template you're using will have the page margins and paper size set correctly for that use-case. For example, if you're using a journal article template provided by the journal publisher, that template will be formatted according to their requirements. In these cases, it's best not to alter the margins directly.

If however you're using a more general template, such as this one, and would like to alter the margins, a common way to do so is via the geometry package. You can find the geometry package loaded in the preamble at the top of this example file, and if you'd like to learn more about how to adjust the settings, please visit this help article on page size and margins.

2.8 How to change the document language and spell check settings

Overleaf supports many different languages, including multiple different languages within one document.

To configure the document language, simply edit the option provided to the babel package in the preamble at the top of this example project. To learn more about the different options, please visit this help article on international language support.

To change the spell check language, simply open the Overleaf menu at the top left of the editor window, scroll down to the spell check setting, and adjust accordingly.

2.9 How to add Citations and a References List

You can simply upload a `.bib` file containing your BibTeX entries, created with a tool such as JabRef. You can then cite entries from it, like this: [Gre93]. Just remember to specify a bibliography style, as well as the filename of the `.bib`. You can find a video tutorial here to learn more about BibTeX.

If you have an upgraded account, you can also import your Mendeley or Zotero library directly as a `.bib` file, via the upload menu in the file-tree.

2.10 Good luck!

We hope you find Overleaf useful, and do take a look at our help library for more tutorials and user guides! Please also let us know if you have any feedback using the Contact Us link at the bottom of the Overleaf menu — or use the contact form at `https://www.overleaf.com/contact`.

References

[Gre93] George D. Greenwade. The Comprehensive Tex Archive Network (CTAN). *TUGBoat*, 14(3):342–351, 1993.

1. Fasham, M. J. R., Ducklow, H. W., McKelvie, S. M. (1990). A nitrogen-based model of plankton dynamics in the oceanic mixed layer. Journal of Marine Research, 48(3), 591-639.