0127
SUPPLEMENTARY DATA

A new approach to improve the quality of mathematical modelling for country-level TB decision-making - development and piloting

Contents

Supplementary Table S1: Objectives of the BRR approach

Proximal outcomes
The tools and processes included in the BRR approach are intended to: ● Describe the consistency of a modelling application with existing evidence and best-practice modelling approaches; ● Provide feedback to modelling teams to improve the quality of a modelling application; and ● Provide a summary judgement on the appropriateness of the modelling in the context of a given application.
Intermediate outcomes
The routine application of these processes is intended to: ● Strengthen the incentives for high-quality modelling work; and ● Tighten the link between modelling results and the evidence used to justify them.
Final outcomes
The long-term goal of this initiative is to: ● Stimulate the progressive improvement of TB modelling as a tool to inform country policy-making, funding applications and National Strategic Plan (NSP) development.

Supplementary Table S2: Reviewer checklist for recording their final assessment of a modelling application**

Principle	**Adequate**[†]	**Inadequate**[‡]
Relevance: are decision-makers, policy questions, constraints, outcomes, perspectives and intervention activities clearly defined?		
Realism: are realistic assumptions made about implementation challenges and the plausibility of assumptions?		
Appropriateness: is model structure and complexity justified and appropriate to the questions and context considered?		
Evidence: is evidence appropriately gathered and checked, with expert opinion validated and uncertainty investigated?		
Validation: are model results and assumptions compared to other relevant evidence, and sensitivities tested?		
Informativeness: are a sufficient range of outputs and outcomes reported to allow for understanding of model scenarios and function?		
Transparency: are technical details clear, including model structure, implementation, scenarios, uncertainties, limitations, evidence and conflicts of interest?		
Timeliness: is the timeline/scope for modelling reasonable, or do deadlines curtail the usefulness of results in an unacceptable manner?		
Country ownership: is there appropriate engagement with and input from local stakeholders?		
Iteration: have the modelling approach, policy scenarios and results been reconsidered in light of input from stakeholders/reviewers/new data?		

*Based on principles for good modelling practice described by the TB MAC/WHO Country-level Modelling Guidance.
[†] Indicates any remaining reviewer concerns are minor.
[‡] Indicates major concerns remain about the modelling application.

Evaluation Approach for the Pilot Study

The evaluation questions addressed in the pilot study are shown in the box below.

Evaluation questions for the pilot study

1. Does the current approach achieve its immediate goals (*Box 1, Proximal Outcomes*), and how do the different components of the process contribute to achieving these goals?
2. If applied routinely, is the approach likely to achieve the long-term goals of this initiative (*Box 1, Intermediate and Final Outcomes*), and how do the different components of the process contribute to this?
3. Does the current approach place undue burden on modellers or other participants in a modelling application, or harm the ability of modellers to provide modelling technical assistance that is timely, relevant, and rigorous? If so, how do the different components of the process contribute to this?
4. Are there ways in which the approach should be modified to improve its efficiency and feasibility?

As part of this evaluation all reviewers and modelling groups were asked to complete a questionnaire, and a semi-structured interview was then conducted to allow participants to provide greater detail around their responses. Questions included in the questionnaire form are shown below.

Questionnaire items for modelling teams

1.1. Reporting Template

- Prior to receiving initial feedback from reviewers, did filling out the reporting template make you reconsider any aspects of your modelling application? (Y/N) If yes, which ones, and what changes did you implement
- Was the reporting template sufficiently clear to you? Which components could use additional explanation? (Y/N) text box
- Were any of the questions or sections challenging to complete? (Y/N) If yes, which one(s) and can you suggest any alternatives or improvements
- Did any of the questions seem redundant, or not useful? (Y/N) If yes, which one(s)
- Approximately how long did it take you to complete:
    - The initial reporting template? Text box
    - The interim reporting template? Text box
    - The final reporting template? Text box

1.2. Benchmarks

- Were any of the benchmarks challenging to report (hard to calculate, or with unclear definition)? (Y/N) If yes, which one(s) and how did you address it
- Did any of the benchmarks seem irrelevant to your modelling application? (Y/N) If yes, which one(s) and how did you address it

1.3. Working with Reviewers

- How satisfied were you with the reviewer selection process? (Not at all satisfied, somewhat satisfied, very satisfied) Text box
- How useful were reviewers' comments? (Not at all useful, somewhat useful, very useful) Text box
- What was useful about the overall review process for you -- please list all. Text box
- How many changes did you make to your modelling application as a result of the review process? Number box

    - Please comment on the magnitude and importance of those changes. Text box
- How satisfied were you with the agreed upon timeline for review? (Not at all satisfied, somewhat satisfied, very satisfied) Text box
    - Did you adjust the timeline in any way during the review process? (Y/N) If yes, what adjustments did you make and why?
    - Did reviewers' input arrive quickly enough to implement changes in your model? (Y/N) text box
    - Would you have benefited from additional time to complete any of the stages or implement changes in your model? (Y/N) text box
- Do you feel that reviewers held sufficient combined expertise to provide feedback on the modelling applications? (Y/N) If no, what areas could have been improved
- Did you consider reviewers fair and objective? Text box
- Was the review process sufficiently clear to you? Which components could use additional explanation? (Y/N) text box

1.4. Self-review
- Did you use the self-review portion?
- How useful did you find the self-review? (Not at all useful, somewhat useful, very useful) Text box
- Do you recommend adding or removing any questions from the self-review? (Y/N) If yes, which ones

1.6. General
- Is there anything that you think should be added to or removed from the overall process? (Y/N) text box
- Overall, how easy was this process to complete? (Very difficult, somewhat difficult, easy)

Questionnaire items for reviewers

2.1. Timeline
- Was the review process sufficiently clear to you? (Y/N) If no, which components could use additional explanation?
- Did you follow the timeline for review agreed upon at the outset of the project? (Y/N) If no, what adjustments did you make and why?
    - Was the timeline settled far enough in advance for you to schedule the time needed to review the application? (Y/N) text box
    - Did you feel that you had sufficient time and opportunity to provide feedback? (Y/N) text box
    - Did you feel that modelling groups had sufficient time and opportunity to respond to your suggestions? (Y/N) text box

2.2. Information Provided
- Do you feel that you had sufficient information from the modelling groups to inform your review? (Y/N) text box
    - Are there additional materials that you believe should be provided?
    - Are there any materials that you did not use to inform your review?
- How did you communicate with the modelling team for clarification (e.g. scheduled phone calls, impromptu calls, emails, etc.)? If multiple forms were used, which did you rely on the most and which was the most useful? Text box.

2.3. Review Template
- Were any of the questions or sections challenging to complete? (Y/N) If yes, which one(s)
- Did any of the questions seem redundant, or not useful? (Y/N) If yes, which one(s)

2.4. General

- Is there anything that you think should be added or removed from the overall process? (Y/N) text box
- Overall, how easy was this process to complete (Very difficult, somewhat difficult, easy)

Each participant's response was reviewed and coded by one of the authors, and a code assigned for every new idea introduced. These codes were discussed, and major themes were identified. The results of this evaluation were used to revise and finalize the BRR approach.

Participant Feedback from the Pilot Study

Feedback is organized responses from reviewers and modellers, and divided into the following thematic areas; components of the process, benefits of the process, challenges and improvements to the process

Sub-theme/ Code	Response	
	Reviewers	**Modellers**
Theme: components of the process		
Structure of process	"The process is well designed and should be effective at improving the quality of modelling applications, provided both sides are interested and engaged. This type of small structure review process is something that I can see built out into the other modelling areas." "The BRR process improved the transparency of the modelling process."	"It [the structure] helped us clarify the shape of the final report." "Being prompted to do it [the BRR] really early on in the application would make it a useful tool for structuring a modelling plan as a whole and help to correctly structure and frame questions when working with stakeholders in a country." "[The BRR] helped us think about how to structure the [country] report and certainly helped us. For future applications we will make sure the reports mention all of these things in this structure." "Summarising the model structure prompts some introspection that can be helpful in ongoing model refinement and responding to the reviewer comments." "There is value in just having the process and it confronts us that we don't have a clear grip on how long this disease lasts on average."
Structure of reporting forms	"The process is very detailed as presented by the document produced, very detailed and lots of steps." "I had the opportunity to give feedback I wanted, and the format was quite specific on that and I had space to review and judge the work as much as I wanted, so overall it was fine." "The reviewing format, at least the first one, was open enough/ there was room enough to extend myself and keep my opinions in my review."	"The report would be useful for structuring a project plan and the modelling planning process as it provides a logical framework. Retrospectively, if I had the BRR report to guide/structure the application it may have informed my approach to analysis and to presenting methods and objectives to stakeholders in-country, including the NTP. Some of the headings outlined in the document serve as discussion points– which again may help to provide a more standardised structure to presentations, workshops etc." "The benchmarking was useful, we often had them in models but were not reporting them, these are the things people want us to report out and we can pair with them other people's reporting." "These questions were good prompts because we had not described to countries what the terms were for the economic analysis. We still would have done something similar, but it was nice to put this into a logical order." "The whole document is reflective and helps you reflect on potential threats. It helps the modeller think about the wider context and usefulness of a modelling application in the wider context of strategic planning. Having BRR for all country-level modelling applications would help to standardise approaches and ensure transparency of methods etc." "[Reporting costing] very tricky if there were more examples from the region of countries that had evaluated this that would be useful. We have been digging through some of the resources that have been mentioned but I still find it difficult and challenging to find things that are directly relevant to the model. This may have changed over the last year."

		"We did not include HIV, as there is very low incidence in [the country] and it was not relevant for this model application. The co-epidemic is also low. HIV is not even a risk factor for TB in [the country]. The country did not want to include this risk factor in the model and wanted instead to focus on the social aspect."
Format/volume of communication	"In terms of the timeline, while we agreed on a week for turnaround, we never know when we'll get a report, so it's hard to anticipate and can arrive at a time that isn't conducive to a quick response...This worked out fine in this case, because there was good communication between reviewees and reviewers and the reviewees had flexibility on their deliverables (rather than the instance where they may have country report deadlines)." "Emails were fine. When we met up in Istanbul there had been a suggestion of a skype call. However, it was hard to settle on a time for a coherent call [across multiple time zones]. A little more integration may have been helpful. At the Istanbul meeting (in person) there was not much to discuss at this point. Only the initial review was available. However, it was useful to clarify in person some of the terminology being used." "There were pretty long lags between communication in general, almost forgetting about it and then all of a sudden this is happening now. It was basically just radio silence from then on - COVID hit a couple weeks after review was submitted, perhaps something had to do with it. Factually speaking we did an initial review, we had 3 reviewers and a lead reviewer and that got submitted back to them." "I'd like to see more back and forth between the modeller and the reviewers." "[We had] no communication with the modelling team that I recall. There was a kick-off meeting in December-ish where we knew this thing was shaping up and we were going to be involved. We did have a little meeting, but it wasn't too substantive in terms of all we knew was there were a bunch of challengers. There was an initial meeting prior to getting all materials where we talked about how it was going to be happening, we talked about a timeline for it- which we didn't follow- and we got a little background on the modelling study - the nature of the work and how supporting government needs. We never interacted with the modeller after we had substantial information like the inputs of the initial review. We didn't have any further communication with them after or during the initial review process they just submitted documents." "I noted that there was unfortunately not much direct communication (most communication was through email) between reviewers. Therefore, [the lead reviewer] ended up summarizing and combining the separate reviews. There was not much time to discuss with reviewers, luckily, they mostly agreed. Therefore, if there 2 reviewers disagree, this may add time pressure to the review process. In this case a barrier to in-person discussions was a time zone issue." "Scheduled phone calls and emails. Need both but email is fine for most purposes. Modellers and reviewers can be left to work out communications between them, when they plan out the timeline for country process and BRR	"There are many ways to approach model structure, the reviewers had a few comments related to the model structure, the purpose of these comments was to have an open discussion around models rather than to critique our model." "[Some issues] would have been cleared up if a conversation was possible."

	review." "The dialogue we never really managed to have a real dialogue after our introductory call. We did not have an iterative discussion." "We had one channel of communication via email and two calls involving the whole reviewing group, modelling and organisers. But I never had a one-to-one exchange with the modelling team, so can't really say I had a channel, but I know it was available but then we didn't get to point to use that channel."	
Ability to act on the results of review		"Some of the comments were very helpful, for example: what should be included in the modelling and what needs to be more explicit and what parameter space we explored and so on." "We were the one being a little slow in the initial moment, but the actual review came quickly. Waiting for the country then getting busy, the review came in a timely way. [In one instance] there was no opportunity to talk about the overall epi stuff, but economic feedback was very useful." "It was a little difficult on our end to get information to the reviewers about when we may need feedback by and when we may be able to provide the report." "Very difficult, given we couldn't complete it and couldn't take on board any of the comments due to the turnaround for the country." "Efficient turn around with clear comments. It was quite simple and easy to respond to the reviewer. Overall an easy and positive experience." "Useful to receive brief and succinct written comments. Had comments been long paragraphs, I may not have had time to read them due to time crunch to complete the project."
Process had parallels with a journal review	"Knowing that there was going to be an initial, intermediate, etc. steps remember it being it straightforward and sounding good at the time and thinking it so structured, being interested in it because it was an interesting way to get peer review on modelling studies, I was intrigued by the process and attempt to do this probably good idea." "It might have been useful to have a joint meeting with the modellers as part of, or just after the Initial Review step. If we had more time to produce the initial review, I could imagine having a call with modellers after we read through the material they submitted but before we write up our review comments" "I think there is still a disconnect between the academic review process approach versus the reality of getting these things done in the field. I think this is a common friction between academia and reality." "Having the modellers respond to the reviews in some way (like in a peer-review) would be important to add to the process."	"This process is a bit like a paper review where some comments are right and somethings are wrong, if we had had sufficient time could have responded." "Not necessarily going to adjust our modelling approach because of the comment." "Even if the process is longer, I feel that short written comments are more useful than a long document and can be followed by an explanatory phone call. This would also help prevent the process from feeling like an audit or full manuscript review."
Theme: benefits of the process		
Benefits for the longer term	"I think it's a really good idea to do this (even if imperfect) because there are so many of these studies being done with these kinds of models, whether it's in	"The only challenging bits were the ones that we did not include, and it was too late to go back and change the code, but this has been useful for planning future activities. I think at

from the BRR process	TB or HIV or malaria or nutrition, there are a lot of these studies that get done for strategic planning or investment cases or other kind of country support work and a lot of it does not get peer reviewed because for a lot of these studies the end point is not a journal it's a report or a document- grey literature - for country, I think it's a real value add, to add this layer of peer-review on it, even if it incrementally makes only modest improvement on the quality of the studies." "For the initial and interim reviews, there was obviously more time to respond. When we got the final version, it had already been submitted, so final comments were more for future applications than relevant for the one we were reviewing."	the latest meeting, we talked about this, but also allowing the programmes to put in their own costs using a toggle thing and seeing how that increased the overall cost of the programme. ...Not necessarily an uncertainty analysis but sensitivity and allowed adjustment to those parameters. we will now have those documents there at those meetings. And it'll be really quick and easy to do on the plane home." "For example, what proportion of people go on to develop chronic lung disease and what's the DALY associated with that, as well as the deaths, and the DALY lost from death from TB depend on how old people are when they die and the life expectancy in country and discounting of life years and discounting rate. I did all this post [analysis] and this will be something included in future reports." "We will definitely change the type of data reported in our model, to match with those requested in the table(benchmarks). We will also add uncertainty analysis in future work." "The other criticism was not including uncertainty ranges around cost, [we did not do that] in this report but addressed it for subsequent reports."
Benefits to the current application - Structural changes to model code		"What we tried to do was generate an automated system in the model, so it just generates the entire Benchmarking report and at that time they were very straight forward." "I had to change a couple of outputs in the model. It was interesting checking to see if all the outputs were available in models – they were."
Benefits to the current application - Changed country discussions		"One question I hadn't even thought about, which was useful was 'what are the major threats to the policies examined?'. We talked to the nation TB programme about novel policies they were interested in and ruled out ones that were impossible, too difficult and risky, apart from clear cost threats, hadn't thought of major threats to new policies except in the context of modelling them. There are other threats like sociological or health systems orientated." "Another comment identified the need to communicate uncertainty in the more aggressive interventions: we raised this comment in discussions with the country team and ended up omitting those aggressive interventions for which there was little available evidence." "We were recommended to be more specific and explicit with our costs, which I think improved the final report."
Benefits to the current application - Changes to the data and/or modelled exercise		"We included additional epi data to inform the trends, and ultimately dropped a handful of interventions for which the evidence was weak. Changes were small in magnitude but helped to improve the overall robustness and credibility of the analysis." "We did change the report as a result of feedback, the main thing being explaining where we got our numbers from. As an example, an x-ray program is going to cost 20,000dollar/year. Feedback was 'where did these numbers come from?' I ended tidying up my excel spreadsheet to show the cost per year as a fixed recurrent cost, and an amount per person, so if you scale up from here to here it's going to cost" "We were asked to do DALYs, I did a post-processing DALYs, As DALYs are not immediately available from the code. Therefore, I had to work out deaths and how many

		DALYs the difference in deaths would make and disability – if we had benchmarks for that it would be really useful."
Satisfaction with reviewer team	"I was able to read the feedback from other reviewers, which was useful, but not from the modelling team."	"It is clear from their comments that these people know what modelling is and that there is not just one way to do something." "So, 2/3 very excellent the modelling one I was a bit less sure they had experiences with TB models and country-level modelling tools, more specifically." "Reviewers were impartial and professional: importantly, we felt that this was more about identifying ways of strengthening the analysis, than performing an 'audit'." "The reviewers chosen were friendly, very knowledgeable and helpful with constructive comments." "I was also impressed that we had the opportunity to exclude reviewers who we thought would not be able to provide an unconflicted report"
Theme: challenges		
Duplicative/repetitive	"I worried [the modellers] were having to duplicate existing work" "The quantity of work might be doubled for the Modelling team (write country report and BRR report). Agreement on a standardized/agreed upon template might reduce this burden (Example when you Write paper there is the introduction, method result and discussion)."	"Some questions were clearly questions that would appear in a country report so there was a lot of cutting and pasting from the report" "Yes, although there is some repetition and ordering in the final report document. In Section 2, introduction and key results come before the methods, which does not follow the expected format of a paper or report. Is this to ensure the reviewer sees the key results first? Report format may flow better if Section 2.2 "main finding recommendations and uncertainties" is part of the results and discussion under heading (3.2). Unless section 3.2 relates more to benchmarks, model validation and comparison of results? It would be good to distinguish this from the modelling method and results with i.e., with different titles Also, in relation to question 3.2.5, which refers to tech specification of the econ, it would be useful to have a subset of econ specific questions. Heading itself is useful."
Ability to provide a timely reviewer response	"The final report came at a crunch time for several team members in our group, so we took almost two weeks to respond. Agreed initially get back to them within a week, however as you cannot foresee exactly when the request for review will come through you cannot be sure everyone will be in a position that week to set aside the time necessary for the review. In theory, it is possible to turn around a week; in practice it may take longer." "My rules of thumb for something like this, 1 week is enough if you know it's coming, if someone just drops something on you 2 weeks is really comfortable and 1 week usually doable. There was a little communication to signal that it was coming".	
Country/external influences on the process	"Time and commitment to complete: Since the modelling team is very much at the mercy to get access to materials, their own timelines were precarious, and their own access not fully guaranteed. Therefore, our external review of that process was not in a strong position to be done or a priority of the NTP, donors." "I think what I was surprised at was that the modellers themselves were in a precarious situation regarding the ability to do the model and access… the NTP was not	"We were waiting on the country to provide costings in order to make a final report. It took a lot longer than expected, but we should expect it to take quite a lot longer than expected. One of the lessons from this is that it is really important to get hold of a Health Economics or finance person the first time you are in/ meet with a country because it is more difficult to follow up with at a later stage, when you are no longer face to face." "A big challenge is that country work moves very stop-start,

	onboard it didn't seem beforehand. So, if the modellers are not in a secure position then our role as external reviewers is going to be severely limited – I think that is going to be more common than not just because of the way programmes work in reality and all the deadline people are making/trying to meet and how those deadlines can change suddenly, and you end up with a not a very profound process." "[The modellers] didn't have control over the timeline because they didn't have direct access or buy-in from the country at that time, so a lot of things had to happen in order for us to be able to do our work - so that was the main issue." "It was like two parallel processes that weren't integrated. The modelling team had no control of the timeline and then if they don't have control of the timeline then we really have no way of working with the modelling group. Our focus, target group is the modelling team, and the modelling target group is buy-in from the donor and the national programme – and they were struggling with that so there was no way we could impose ourselves onto that process." "Funder is the most important driver for this work, modelling and country have different perspectives, may not want too many people to look into data and what they propose, as there are a lot of assumptions and uncertainty. Funder has the least barriers."	not a homogenous long process." "Messiness of the policy process where the NTPs are rightly guiding the modelling (that's how it is supposed to be), but given all their competing priorities, it can be very hap hazard, this makes it very difficult to plan fitting in a BRR process." "We need additional time on the modelling side with countries not necessarily involved in the BRR process." "The integration of the policy cycle and modelling cycle to the timeline of the BRR, even with all the flexibility of the BRR, was beyond us." "I don't see what you could do to improve it except with more pressure in the NTP and much higher prioritization on NTP to have the modelling process done in a very structured way." "Make a very strong argument that the burden of making sure this process gets completed does not just fall to the modelling team." "Unless the country thinks it is important, the issue we found is likely to occur more frequently." "Our team was late for the final report deliverable as we didn't get data from the country on time. The model was ready to go but decisions related to the model structure still had to be made. This caused a 2-month delay." "It was not challenging to complete, just some sections required a little more thought. For example, especially the politics around this particular application and how to frame that, but it helped when we got clarification about who would be seeing the report." "Generally good to have explicit agreements in place early in application to determine how results to be disseminated/shared and what the restrictions should be. Good to have a wider discussion on this topic."
Model infrastructure not fit for benchmark purpose		"Duration of active TB, that was difficult to estimate, because it's not a direct variable, but a competing risk variable." "Access_PCT (private sector), was relevant but not straightforward to get from the model. It was good to review with model developers and the team team" "(TX_Private_pct) was not captured in the model but can infer indirectly through assessment of under reporting; the model does not provide direct estimate (Complete_pct & cure_pct)– treatment outcomes. The model has a single parameter for treatment success i.e., not disaggregated by cured and completing treatment." "All very important components, which were in our model, but not always in our output. One exception which was not in our model but was an important output was the distinction between first episode and recurrent MDR which is useful to do but not in our models currently."
Timing (both time available for a particular step, and when it would happen)	"If there was a tight timeline for countries engaged with a review process, this would likely not work as well." "Some Global Fund modelling applications in the past have been a little too rushed. However, modellers had more time in this present round, and the BRR process needs this longer time scale. Suggest modellers and	"If we had had enough time where the NTP, Global Fund, us and reviewers were all working in a good timeline it would have been useful to strengthen it and have feedback, but that didn't happen because there was not enough time." "With the timeline it really clarified where this review process needs to come in the modelling application stage and perhaps

	reviewers agree on a joint timeline (tentative, change as needed) for both country application and the BRR process, so that BRR stages coincide with stages of the application in order to be most useful." "It was never clear that we would be able to complete the process or number of steps. I remember the very beginning when we established a timeline for the process- the BRR evaluation has a lot of steps to it and it takes some time between those steps and when we started the whole thing it was already very clear that the modelling group was behind on their own ability to get the work done, because they had to link up with the country and have an agreement with them and that hadn't happened yet and they were still trying to get access and an agreement. While we were trying to set up a plan. So, for me at the very beginning it was clear. Between their timeline and our timeline there was no way to reconcile the dates." "It would have been better if there was more (I understand there was some kind of communication problem between the modelling team and NTP), because it was not very clear what the timeline was going to be. So, we were working on very short notice on this review and in the end we agreed on a time and it was okay. However, in terms of time, it would have been better to be clearer about the full timeline from the beginning, but I understand that not only up to us but also the country." "Good to hear feedback from the modelling team on how helpful the reviewer's comments were. However, from the reviewer perspective, it was not costly too of my time and was a good opportunity for international collaboration."	a bit later. I can see it would be difficult to figure out when exactly this BRR process needs to take place." "The only challenging bits were the ones that we did not include, and it was too late to go back and change the code, but this has been useful for planning future activities." "The process also raised questions about what the best time is to start and complete a BRR application - BRR is only a portion of the work, what is a good time to fill out this especially if it is a long application. When you begin an application is there a timeline for starting and submitting a self-evaluation?"
Data constraints	"Reviewing the cost and CEA components. In some cases, there was insufficient background information to judge the quality of the assumptions so benchmarking them against other countries was the only option for quality assurance. The modelling team was more focused on the epi modelling. They use cost curves which were a bit oblique, it was hard to dig out information from them." "We didn't get into any discussion about what's the epidemic in the country; it was really focused only on the model. So, our review was only on the specifics of the model, not on whether the model reflected the programme's ability to really achieve what it says it was going to achieve. We are a step removed from reality."	"It's hard to get the countries to tell you what their costs are, the people you meet when doing National TB programme work, rarely know the answers to these questions." "For example, TB incidence (could make the same comment for LTBI prevalence) and many things with TB, we just don't have good data on." "Perhaps my previous comment on hierarchy of data sources [applies], however this is not a major comment, but it may be useful going into the future to differentiate what is data and what is not data."
Theme: improvements to the process		
Suggested follow up/ comparison	"It would be nice to see what happened with the final product, and if our comments were taken on board. If the modelling team had the opportunity to see our review. We did our first part of reviewing it would be interesting to see what happened with that." "It is a little disheartening to have to review out into the ether and never know if it was read or used, or how it was helpful or not."	"Useful to have /see what other people's reports look like. Would be good to see how one measures up to a standard."
Suggested clarity of BRR purpose	"It wasn't completely clear at the time what the studies were that we were going to be evaluating exactly and maybe not 100% clear what material we would get from the teams doing the studies that we were evaluating. "	"What do you do then if the reviewer misses the mark, then the modelling team responds, 'no it's like this'? What then happens, does the funder then get very upset? Is that the situation we would have had to deal with if we had had time to

		really address and incorporate those comments?" "It's not a one-size-fits-all with all modelling applications, or whose funding it or what the process is designed to inform." "Easy. However, this depends what the modeller(s) and reviewers are looking to glean from the BRR process overall. If this is more a technical review of modelling methods/approach, then the report would be tailored to this. If review is of methods in a wider context of program planning, then emphasis different and maybe more time needed for discussions between modeller, reviewer, and stakeholders/beneficiaries."
Suggested improvements to the structure of the process	"It would be better if the reviewers could be involved from the beginning." "I guess in terms of communication knowing what the pipeline of studies are and whether I'm going to be called upon again for one of these or not would be useful." "If there is an opportunity for the country team to interact with the reviewers, this may be helpful to the overall process. This is true for the funders too. This may be more efficient especially if reviewers are able to understand the country's (NSP's) specific targets (elimination, 2050 targets, etc.). However, there may not be a clear way to involve the country team and funder in the discussion." "The donor and then country have to really be on board to make it happen. They cannot be imposed from the outside reviewers." "The Global Fund might consider designating a proctor to backstop the BRR process. Someone to make sure both sides feel the process gets off on the right foot and proceeds smoothly. At outset, modellers and reviewers should lay out the expected timeline for the country application and let that determine the timeline for BRR review (subject to change of course). Modellers and reviewers should start talking quite early about the questions the modelling will answer for the country, limitations, framing. Since questions/answers often need to be iterated, the main questions could potentially be associated with the timeline as well." "I think that if part of that cycle modellers could respond to review questions before reviewers finalise the interim report, that would be good. Or alternatively, you submit your interim report but the modellers respond to that interim report prior to the next phase of the review- maybe less burdensome on modellers take interim report as is and they then have significant amount time to address it as they move forward and then you hope by the next phase of the review, they have addressed those things. Just like when you submit to journal and you get a revise and resubmit – you get a bunch of comments from reviewers and then you have to answer them one way or another, that's familiar to everyone involved and it would work nicely here and ultimately that would have a bigger effect on having the review influence modellers in terms of making the study better or sharper, and it's not a waste of time if they were going to published those results in a journal article they would have to address those comments anyway. I think what's going on here is sometimes these studies don't end up	

	getting published so never really go through true peer-review, so this is sort of a substitute for it." "One [improvement] is doing something prior to completing the initial review – whether that's the modellers doing a presentation or just having a call where the reviewers have reviewed the material and have a set of questions for modellers and then we go back write up our review."	
Suggested improvements to the reporting forms	"The specific Benchmarks were more clearly laid out for epi-section than for cost. For example, I relied on other data sources such as GDF to review unit costs." "It would be helpful to have, if possible, the data collation workbook, modelling excel sheet with input data, epi data and prog data. However, I did realize this all may be sensitive or and confidential. I also note it would be useful to have access to the NSP's document which contains what their strategy for TB control is. Is the objective a WHO, feasible or eradication target?" "One thing that all of the reviewers agreed on, was that in terms of the material provided in order to do the review it raised a lot of questions many of our comments were asking for more details on certain items, such as, "they said they did a calibration but what were the targets for calibration", there were several things where multiple reviewers were requesting more information on parts of the modelling process. Another example was when there were some scenarios described which were described qualitatively [in terms of] different levels of intensity but it was never written quantitatively in the model- what exactly is that scenario, I don't exactly remember the terms but it was something like "aggressive scale-up" or "moderate scale-up" but it wasn't clear in the model when you are implementing that how exactly turning it into something concrete in the model – aka coverage levels in interventions. So, these were the types of things we were asking for with the idea there would be another round in evaluation or review." "It would be very nice to get some documents that talk about implementation and would justify the decisions made. So, there was no way for us to justify what the modelling group had taken as their implementation parties and protocols. It is just that the modellers said "this the process, this is what we have been told" so there was no way to triangulate/verify that that was adequate or that was all of it. There was no triangulation to give more insight into "are those the right determinants? Are those the right implementation choices? Could it be done? Was it feasible?". There was no assessment of feasibility. For implementation everything is about feasibility." "I missed some information regarding model description and calibration methods. Given the review process was cut short I supposed these would have been provided in a second phase. For the initial review what the modelling team sent was enough to have an initial of the work and the primer/summary (from BRR) was good enough to start a review. But of course, something will be missed as part of the process and I guess part of this process was to follow this up and receive more information on calibration and all the technicalities we didn't see at that point. From the format perspective it's enough, it's just more technicalities in the document I would have liked	"I quite liked having a list of benchmarks. However, there could be some kind of hierarchy in what constitutes better data for model targeting for example between prevalence data (if there is a survey) and incidence. If we simply list Benchmarks, one might presume that we give equal value to a prevalence survey and the estimates from IHME or WHO. It may be more useful in the BRR to be clear and emphasize what is based on data and what is based on educated guesses or from another model (IHME and WHO)." "Overall, the report structure is clear, and the headings are good but more information and examples for main headings would be useful." "[It took me] more than 4 hours, due to the level of detail included in the report. If this had been a full BRR process from start of/alongside application, it would have helped to structure the report."

	to see." "Certainly, if they had more detail it would have been possible to provide a more comprehensive review. But in terms of the initial report template that the modeller filled out, that template was reasonably good- in terms of the template itself, but as it was filled out by modellers, in my particular case, you wished there was more detail there." "Maybe something on the model itself, some kind of primer on the model [would be useful], in case the reviewers are not familiar with the particular model." "Potentially background documents on the model itself and how it works could be added and could be helpful. The detail provided was very light (gave you an example- description of strategies above) it was a little thin so it just constrain how constructively we can critique it as there is not enough information to say if this is good or bad or could be improved in some way...if there was a model I didn't know there was really no information the template provided explaining model and how it was constructed and works- was it a dynamic model or not, individual micro simulation or Markov model or is it all of those things. How does it take into account age? A sort of primer on the models would be useful, perhaps there is already a document written that could give some background on the model. I think if I got a model I didn't know anything about, I would have been really looking for that."	

BRR Materials Summary

This document provides a summary of the different materials used in the TB MAC Benchmarking, Reporting, and Review (BRR) Approach.

1. Background

The TB MAC Benchmarking, Reporting, and Review (BRR) Approach is a set of tools intended to improve the quality and transparency of country-level TB modelling applications. The components of the BRR Approach are (1) a set of quantitative benchmarks that can be used to assess the realism of modelling assumptions, (2) a standardized reporting format to collect information on the modelling application, and (3) a review process that makes use of the benchmarks and reporting format. This material is not intended to be prescriptive, but rather to provide a structure for a summary of the entire modelling application and process. This allows for easy understanding of the application, as well as establishing a platform on which to base discussions between modelling technical assistance (TA) groups and reviewers. This material and process was developed by the TB Modelling and Analysis Consortium through consultation with a wide range of stakeholders, including technical experts, modelling technical assistance providers, funders, and other stakeholders. The reviews conducted through the BRR approach represent the views of the reviewers themselves, and do not represent the position of TB MAC or other organizations involved in the review.

The review process consists of two stages—an initial review and a final review. At each stage of the review, the modelling group is expected to complete a standard reporting template. This report is sent to the reviewer(s), who complete their review using the review template. The review is intended to be an open process (unless a decision is made to have blinded review), and is to be conducted during the modelling application to allow for feedback to the modelling group. At the completion of the review, the final review report is shared with a list of recipients agreed to before the review begins. In the detailed description below, ***bold italics*** highlight templates and forms that are to be used as part of the review.

2. Procedure for review

Preparation

The need for review will typically be identified by a funding or technical agency involved in the planning of the modelling application. At their request, the review coordinator will liaise with the modelling group to collect basic information about the planned modelling application, using the ***summary information*** document. As the timeline of the modelling application may be uncertain at this early stage, reviewers will only be engaged when the modelling application begins.

When the modelling application begins, a reviewer (or reviewers) will be engaged by the review coordinator to conduct the review. At this point the summary information document will be shared with the reviewers, and a timeline for the review developed in discussion with the modelling team. The distribution list for the review should also be decided at this point, identifying the individuals or organizations that will (i) receive materials as part of the review, and (ii) receive the final review report (these two lists can be different). These lists should be developed with input from the modelling group, the funder of the modelling, and the organization receiving modelling technical assistance. These decisions should be recorded in the ***distribution list*** document. If a confidentiality agreement is required this should also be completed at this point. The review coordinator will be copied on all communications between the modelling group and reviewers.

Initial review

At an agreed-upon date, the modelling group will provide the reviewer(s) with an initial report, describing the context and evaluation questions of the modelling application, a description of methods used, and a set preliminary results and modelling benchmarks. This report will be completed using the ***initial report template***, though the modelling group may also provide additional technical documentation to facilitate the review. The reviewer(s) will assess the initial report and accompanying materials, and complete their review report using the ***initial review template***, within the

turn-around time agreed to earlier (typically 1-2 weeks). Following receipt of this review report, the modelling group will develop a brief response responding to any major questions/recommendations included in the review. If useful, a call/video conference can be held at this point between the reviewer(s) and modelling group to discuss the review and the response.

Final review

At an agreed-upon date, the modelling TA will provide the reviewer(s) with the final report, completed using the ***final report template***. The format of initial and final report templates are similar, so any content that is unchanged can be copied directly between documents. The reviewer(s) will complete their review using the ***final review template***, and return this to the modelling group within the turn-around time agreed to earlier (typically 1-2 weeks). Following receipt of this review report, the modelling group will develop a brief response responding to any major questions/recommendations included in the review. If useful, a call/video conference can be held at this point between the reviewer(s) and modelling group to discuss the review and the response. Any remaining areas of disagreement between the parties will be documented and included with the final review. Both the reviewer and the modelling group will be asked to sign-off on the final review and response documents. These documents will be shared with the organizations included on the distribution list.

Debrief and next steps

After the completion of the review, the review coordinator will debrief with the reviewers and modelling team separately, to collect feedback on the process to improve the quality and utility of future reviews, and answer any remaining questions.

3. Abbreviated review and self-review

For some modelling applications it may not be practical to complete all of the review stages described above. In this situation the review format can be revised to omit one of the review stages (likely the initial review), so that only a single review is performed. In other situations, it may be useful to conduct a self-review (particularly, comparing modelling results to the quantitative benchmarks) even though independent peer review is not done. This self-review can be completed using the final review report.

BRR Summary Information

Organization/individual(s) providing modelling TA	
Country/region modelled	
Organization requesting modelling	
Other organizations involved	
Organization funding modelling	
Key contacts for each team	
Programme area being informed	
Decision process being informed	
Final deliverable	
Start date of modelling application	
Planned deliverable due date for modelling results	

BRR Distribution List

A record of individuals to receive review documents during the BRR process.

1. List of individuals/organisations receiving review materials
Expected to be primarily the modelling TA and reviewer teams. Materials not to be shared outside of this list.

Individual	Email address	Organisation	Role

2. List of individuals/organisations receiving final review report
Expected to be a wider distribution list, potentially including funders, requesting organisation and other stakeholders

Individual	Email address	Organisation	Role

BRR Initial Report

Section 1: Executive Summary

Please provide a summary of the background, modelling approach, major analytic findings, and next steps for the planning process. *Suggested word count: 400-1000 words*

Section 2: Introduction and Main Results

2.1 EVALUATION QUESTION

2.1.1 What is the primary research question for modelling? What is the primary audience for modelling results? *Suggested word count: 50-200 words*
2.1.2 What is the population being modelled, and are there sub-populations of particular interest? *Please note if the population being modelled is different from the population of interest for decision-making. Suggested word count: 50-200 words*
2.1.3 What policy alternatives are compared, and how were these identified? *Please describe policy details, comparators, target populations. Suggested word count: 50-200 words*
2.1.4 What are the primary outcomes used to summarise health or epidemiological effects of policy alternatives? *Suggested word count: 50-200 words*
2.1.5 What type of economic analysis is being conducted, and what are the primary metrics used to report economic results? *E.g. Cost-effectiveness analysis, benefit-cost analysis, budget impact analysis. Metrics could include the incremental cost per DALY averted, net benefit estimates, projections of budgetary need and funding gaps. Suggested word count: 50-200 words*
2.1.6 How are optimal policies chosen? *E.g. by comparing cost-effectiveness ratios to a threshold, maximizing projected incidence reductions within a budget constraint, consideration of other criteria such as the equity implications etc. Suggested word count: 50-200 words*

2.2 INITIAL MODELLING RESULTS

2.2.1 What are the main findings and policy recommendations of the modelling? *Please describe key quantitative outcomes for changes in service volume and primary health outcomes. Suggested word count: 200-500 words*

2.2.2 What are the major uncertainties or untested assumptions of this modelling? How were these limitations presented to decision-makers? *Please highlight factors that could lead to incorrect decisions being made. Suggested word count: 100-300 words*

Section 3: Methods

3.1 MODELLING PROCESS

3.1.1 Which stakeholders (local partners, funders, technical agencies or others) are participating in the modelling application? *Name participating stakeholders, and describe how they are involved. Suggested word count: 50-200 words*
3.1.2 What activities are being undertaken to support local capacity building or institutionalisation? *Suggested word count: 50-200 words*
3.1.3 Are there any conflicts of interest (including the review process, if relevant)? *If so, state how these are being managed. Suggested word count: 50-200 words*

3.2 MODELLING OUTCOMES

3.2.1 Are results consistent with modelling benchmarks and other relevant comparison data? *See Section 4 for benchmarks. Please describe important deviations from these benchmarks. Suggested word count: 50-200 words*
3.2.2 If there are deviations, how should these be interpreted? *Suggested word count: 50-200 words*
3.2.3 Are other steps being taken to validate the model? *Suggested word count: 50-200 words*
3.2.4 What uncertainty and sensitivity analyses are conducted, and what conclusions are drawn from these for policy recommendations? *Suggested word count: 50-200 words*

3.2.5 Please describe the technical specifications of the economic analysis. *As is relevant, this should include:*

- *The study perspective.*
- *The major cost categories and program areas included/excluded from the costing, with justification if necessary.*
- *Major sources of cost data.*
- *The time horizon for the analysis.*
- *Whether future costs and/or health benefits were discounted, and the rate used.*
- *Whether economic or financial costs were estimated.*
- *Whether and how economies of scale/and scope were considered.*
- *The cost year and currency for results, and how inflation was dealt with.*

Suggested word count: 200-500 words

3.2.6 Is empirical evidence available to support assumptions around the magnitude of changes in intervention coverage, quality or effectiveness, by intervention? *If yes, describe the empirical evidence. If not, has this been clearly communicated to the requesting organization? Suggested word count: 50-200 words*

3.3 MODELLING REPORT

3.3.1 Is there a more detailed model report that provides technical details of the model approach, including model structure, parameterization, cost estimates or functions, application setting and results? *If so, please provide text, a citation or link. Suggested word count: 50-1500 words*

Section 4: Benchmarks

4.1 GENERAL EPIDEMIOLOGICAL BENCHMARKS

These benchmarks describe general features of TB epidemiology, and are assumed to apply to most settings in which TB is being modelled to evaluate policy/intervention options. Unless stated, benchmarks apply to the HIV-negative population. Disease definitions (active TB, latent TB) follow standard definitions described by the WHO, as operationalised in the model. For models that provide a range of results (stochastic models, or probabilistic analyses) benchmarks should be compared to the point estimate (mean, median) reported from the model.

Benchmark name	Description	Populations / settings	Calculation	Benchmark	Value
cum_inc_adult_0-5	Cumulative incidence of active pulmonary TB over the first 5 years following *M. tb* infection, no reinfection (%)	Cohort of adults (or general pop) with no prior TB exposure, no risk factors influencing TB progression risks	$\mathbf{(a_0 + \ldots + a_4)/b0 * 100}$ $\mathbf{a_t}$ = predicted new TB cases arising in year **t** $\mathbf{b_t}$ = cohort size at start of year **t**	4-15%	
ann_inc_adult_5p	Annual incidence of active pulmonary TB for individuals >5 years after *M. tb* infection, no reinfection (%).	Cohort of adults (or general pop) with LTBI, no risk factors influencing TB progression risks	$\mathbf{a_{t>5}/b_{t>5} * 100}$ $\mathbf{a_t}$ = predicted new TB cases arising in year **t** $\mathbf{b_t}$ = cohort size at start of year **t**	<0.2%	
tb_mort_no_tx	Case fatality (probability of death before self-cure) for active TB, in the absence of treatment	Cohort of adults (or general pop) with active TB disease, no risk factors influencing mortality risks	**a/b * 100** **a** = no. individuals dying **b** = no. individuals in an initial cohort with active disease	40-70%	

tb_dur_no_tx	**Mean** duration of active pulmonary TB in the absence of treatment (years)	Cohort of adults (or general pop) with active TB disease, no risk factors influencing mortality risks	**a/b** **a** = total life-years spent with active TB for initial cohort with active TB **b** = no. individuals in an initial cohort with active disease	1.5-4.0 years	
part_imm_prior_inf	Reduction in the risk of primary TB afforded by prior *M. tb* infection (percent)	Cohort of adults (or general pop) with prior *M. tb* infection compared to matching cohort with no prior *M. tb* infection. No risk factors influencing TB progression risks	**(1-a/b) * 100** **a** = 5-year cumulative TB incidence for cohort with prior *M. tb* infection, following new infection **b** = 5-year cumulative TB incidence for cohort with no prior *M. tb* infection, following new infection	40-85%	

Sources for general epidemiological benchmarks

1. Sloot R, Schim van der Loeff MF, Kouw PM, Borgdorff MW. Risk of tuberculosis after recent exposure. A 10-year follow-up study of contacts in Amsterdam. Am J Resp Crit Care. 2014;190(9):1044-52.
2. Trauer JM, Moyo N, Tay E-L, Dale D, Ragonnet R, McBryde ES, et al. Risk of Active Tuberculosis in the Five Years Following Infection . . . 15%? Chest. 2016;149(2):516–25.
3. Vynnycky E, Fine PE. The natural history of tuberculosis: the implications of age-dependent risks of disease and the role of reinfection. Epidemiol Infect. 1997;119(2):183-201.
4. Sutherland I. The ten-year incidence of clinical tuberculosis following "conversion" in 2550 individuals aged 14 to 19 years. TSRU Progress Report. The Hague; 1968.
5. Ferebee SH, Mount FW. Tuberculosis morbidity in a controlled trial of the prophylactic use of isoniazid among household contacts. Am Rev Respir Dis. 1962;85:490-510.
6. Tiemersma EW, van der Werf MJ, Borgdorff MW, Williams BG, Nagelkerke NJD. Natural history of tuberculosis: duration and fatality of untreated pulmonary tuberculosis in HIV negative patients: a systematic review. PLOS ONE 2011; 6(4): e17601-e
7. Andrews JR, Noubary F, Walensky RP, Cerda R, Losina E, Horsburgh CR. Risk of progression to active tuberculosis following reinfection with Mycobacterium tuberculosis. Clin Infect Dis 2012; 54(6): 784-91.
8. Brooks-Pollock E, Becerra MC, Goldstein E, Cohen T, Murray MB. Epidemiologic inference from the distribution of tuberculosis cases in households in Lima, Peru. J Infect Dis 2011; 203(11): 1582-9.
9. Sutherland I, Svandová E, Radhakrishna S. The development of clinical tuberculosis following infection with tubercle bacilli. 1. A theoretical model for the development of clinical tuberculosis following infection, linking from data on the risk of tuberculous infection and the incidence of clinic. Tubercle 1982; 63(4): 255-68.
10. Clark M, Vynnycky E. The use of maximum likelihood methods to estimate the risk of tuberculous infection and disease in a Canadian First Nations population. Int J Epidemiol 2004; 33: 477–84.

4.2 COUNTRY-SPECIFIC EPIDEMIOLOGICAL BENCHMARKS

Benchmarks describe country-specific features of TB epidemiology. Analysts can make comparison to the series of estimates most appropriate to their estimation task, possible options are shown below the table. Comparison values may be subject to estimation error, and an exact match is not required.

Benchmark name	Description	Calculation	Population / settings	Benchmark	Value	Benchmark value	Source used for benchmark
tb_incid_level	General population TB incidence rate (all forms) in the most recent available year (per 100,000)	$\mathbf{a_t/b_t * 100{,}000}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Use uncertainty interval provided by source of burden estimates (see below table)			
tb_incid_trend	Annual percent change in general population TB incidence rate (all forms) over the past 5 available years (%)	$\mathbf{((a_t/b_t) / (a_{t-5}/b_{t-5}))^{0.2} *100-100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Interval to be created from point estimate from source of burden estimates, +/-2 percentage points			

tb_mort_level	General population TB mortality rate (all forms, including TB-HIV) in the most recent available year (per 100,000)	$\mathbf{a_t/b_t * 100,000}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Use uncertainty interval provided by source of burden estimates (see below table)			
tb_mort_trend	Change in general population TB mortality rate (all forms, including TB-HIV) over the past 5 available years (%) and annualized change (%)	$\mathbf{((a_t/b_t) / (a_{t-5}/b_{t-5}))^{0.2} *100-100}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Interval to be created from point estimate from source of burden estimates, +/-2 percentage points			
tb_prev_level	General population TB prevalence (per 100,000), in years for which a nationally-representative TB prevalence survey is available	$\mathbf{a_t/b_t * 100,000}$ $\mathbf{a_t}$ = total prevalent TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Only assess if recent survey conducted. Results to be compared for forms of TB assessed in survey.			
mdr_naiv_level	Prevalence of MDR-TB among treatment-naive notified TB cases, in the most recent available year (%)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = MDR-TB cases in year **t** (tx naive) $\mathbf{b_t}$ = total TB cases in year **t** (tx naive)	Individuals with active TB, treatment naive	Where recent DRS data are available these are expected to be high quality			
mdr_expd_level	Prevalence of MDR-TB among treatment-experienced notified TB cases, in the most recent available year (%)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = MDR- TB cases in year **t** (tx exp) $\mathbf{b_t}$ = total TB cases in year **t** (tx exp)	Individuals with active TB, treatment experienced	Where recent DRS data are available these are expected to be high quality			
tb_incid_hiv	Percent of incident TB cases among HIV positive individuals, in the most recent available year (%)	$\mathbf{a_t/b_t * 100,000}$ $\mathbf{a_t}$ = incident HIV-pos TB cases in year **t** $\mathbf{b_t}$ = total incident TB cases in year **t**	General population	Only settings with HIV prevalence over 5%			
hiv_prev	HIV prevalence (%)	$\mathbf{a_t/b_t * 100,000}$ $\mathbf{a_t}$ = total HIV-pos population in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	Only settings with HIV prevalence over 5%			

Options for country-specific comparison data

1. WHO TB burden estimates (http://www.who.int/tb/country/data/download/en/).
2. IHME TB burden estimates (http://ghdx.healthdata.org/gbd-results-tool).
3. Locally developed TB burden estimates.
4. Results of nationally-representative TB prevalence surveys.
5. Results of nationally-representative TB drug-resistance surveys, or high-quality drug-resistance surveillance (DRS) data.
6. In some circumstances model incidence estimates could be compared to national TB notifications data, adjusted for known differences (under-reporting, incomplete case detection, false-positive diagnosis) as relevant.

4.3 COUNTRY-SPECIFIC ECONOMIC BENCHMARKS

These benchmarks describe features of TB program resource utilization that are assumed to be country-specific. Analysts can make comparison to the data/estimates most appropriate to their estimation task, possible options are shown below the table.

Benchmark name	Description	Calculation	Populations / settings	Considerations	Value	Benchmark	Source used for benchmark
tb_spending	Total TB spending (inpatient and outpatient costs of TB care), including diagnostics, treatment (first line and MDR), program support and management costs) for the most recent year	$\mathbf{a_t}$ = spending in year **t** for all TB activities	Individuals receiving TB services	Benchmark applies to modelling applications designed to inform program budget estimates			
tb_cost_flt	Unit cost per person month of first line treatment	$\mathbf{a_t}$ = cost per person month for first line treatment in year **t**	Individuals receiving first line treatment	Benchmark applies if country has previously reported in GHCC or WHO World TB Report			

Options for country-specific comparison data

1. Recent program budgets or expenditure analyses (for tb_spending benchmark)
2. Unit costs estimates provided by the Global Health Costing consortium (GHCC) (https://ghcosting.org/pages/data/ucsr/app/)
3. Data/estimates available in the most recent World TB Report (http://www.who.int/tb/data/en/)

4.4 ADDITIONAL STANDARD OUTPUTS

These outputs describe features of TB epidemiology and program performance for which no benchmark is provided, but which are useful for interpreting model assumptions and results.

Output name	Description	Calculation	Populations / settings	Considerations	Value
Epidemiology					
ltbi_prev	Percentage of total population infected with latent *M.tb* infection (LTBI), in most recent year (%)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total individuals with LTBI in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	The best way to calculate these quantities will differ between models. The calculation method is provided as an example, but a different approach could be used if	
recent_pct	Percent of incident TB cases due to recent infection (*M.tb* infection or reinfection	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** due to recent infection	Incident TB cases		

	within the last **5** years), in most recent year (%)	$\mathbf{b_t}$ = total incident TB cases in year **t**		there is a better approach for your model.	
ari	Annual rate of *M.tb* infection for uninfected individuals, in most recent year (per 100 person-years)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total individuals newly infected with *M.tb* in year **t** $\mathbf{b_t}$ = total uninfected pop. in year **t** (without LTBI or active TB)	Population without prior *M.tb* infection		
eff_cont_case	Average number of new *M.tb* infections / reinfections produced by an infectious case, in most recent year.	$\mathbf{a_t/b_t}$ $\mathbf{a_t}$ = total individuals infected or reinfected with *M.tb* in year **t** $\mathbf{b_t}$ = total TB incidence in year **t**	General population		
duration_tb	Duration of active TB (ie to death, self-cure, or treatment), in most recent year.	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
Care cascade [only include public sector]					
access_pct	Percent of all incident TB cases that will access TB diagnosis, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases	Leave blank If a particular transition is not modelled.	
diag_pct	Percent of all incident TB cases that will receive a positive TB diagnosis, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
notif_pct	Percent of all incident TB cases that will be notified, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
init_pct	Percent of all incident TB cases will initiate treatment, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
complete_pct	Percent of all incident TB cases will complete a treatment regimen, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
cure_pct	Percent of all incident TB cases that will be cured via treatment, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
false_pos_pct	Percent of notifications without TB (ie false positive fraction), for most recent year	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total notifications with TB in year **t** $\mathbf{b_t}$ = total notifications in year **t**	TB notifications		

tx_private_pct	Percent of TB cases treated in private sector, for most recent year	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = TB cases initiating treatment in private sector in year **t** $\mathbf{b_t}$ = total TB cases initiating treatment in year **t**	TB cases initiated on treatment		

4.5 POLICY PROJECTIONS

These outputs describe epidemiological outcomes produced by policy projections.

Output name	**Description**	**Calculation**	**Populations / settings**	**Value**
fut_incid_trend_sq	Annual percent change in general population TB incidence rate (all forms) over the next 5 years (%), for policy scenario describing continuation of current policy and intervention coverage (ie 'status quo'), if produced	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_mort_trend_sq	Annual percent change in general population TB mortality rate (all forms) over the next 5 years (%), for policy scenario describing continuation of current policy and intervention coverage (ie 'status quo'), if produced	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_incid_trend_max	Annual percent change in general population TB incidence rate (all forms) over the next 5 years (%), for policy scenario describing maximal reduction in TB incidence, of all realistic* scenarios examined.	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_mort_trend_max	Annual percent change in general population TB mortality rate (all forms) over the next 5 years (%), for policy scenario describing maximal reduction in TB mortality across, of all realistic* scenarios examined	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	

* 'Realistic' implies scenarios designed to represent policies that could feasibly be implemented based on available technology.

BRR Initial Review

Initial review (reviewer): subsequent to an assessment of the interim report, please highlight any concerns around the initial modelling results, including any recommendations for changes or additional work. *Suggested word count: 1500 words*
Initial review response (modelling group): please respond to the reviewer comments above, including any proposals to address these recommendations through changes to the work plan. This will provide a basis for a discussion call between the modelling group and reviewer. *Suggested word count: 1000 words*

BRR Final Report

Please copy-paste from the previous report where relevant, highlighting any noteworthy changes.

Section 1: Executive Summary

Please provide a summary of the background, modelling approach, major analytic findings, and next steps for the planning process. *Suggested word count: 400-1000 words*

Section 2: Introduction and Main Results

2.1 EVALUATION QUESTION

2.1.1 What is the primary research question for modelling? What is the primary audience for modelling results? *Suggested word count: 50-200 words*
2.1.2 What is the population being modelled, and are there sub-populations of particular interest? *Please note if the population being modelled is different from the population of interest for decision-making. Suggested word count: 50-200 words*
2.1.3 What policy alternatives are compared, and how were these identified? *Please describe policy details, comparators, target populations. Suggested word count: 50-200 words*
2.1.4 What are the primary outcomes used to summarise health or epidemiological effects of policy alternatives? *Suggested word count: 50-200 words*
2.1.5 What type of economic analysis is being conducted, and what are the primary metrics used to report economic results? *E.g. Cost-effectiveness analysis, benefit-cost analysis, budget impact analysis. Metrics could include the incremental cost per DALY averted, net benefit estimates, projections of budgetary need and funding gaps. Suggested word count: 50-200 words*
2.1.6 How are optimal policies chosen? *E.g. by comparing cost-effectiveness ratios to a threshold, maximizing projected incidence reductions within a budget constraint, consideration of other criteria such as the equity implications etc. Suggested word count: 50-200 words*

2.2 MODELLING RESULTS

2.2.1 What are the main findings and policy recommendations of the modelling? *Please describe key quantitative outcomes for changes in service volume and primary health outcomes. Suggested word count: 200-500 words*
2.2.2 What are the major uncertainties or untested assumptions of this modelling? How were these limitations presented to decision-makers? *Please highlight factors that could lead to incorrect decisions being made. Suggested word count: 100-300 words*
2.2.3 What are the major threats to success of the novel policies examined? *Suggested word count: 100-500 words*
2.2.4 What is the most urgent or important research needed to confirm these findings? *Suggested word count: 50-200 words*
2.2.5 How will these modelling results be used in the policy process? *Particularly highlight if there is any evidence of impact of the results, or likely to be in the near future. Suggested word count: 50-200 words*

Section 3: Methods

3.1 MODELLING PROCESS

3.1.1 Which stakeholders (local partners, funders, technical agencies or others) are participating in the modelling application? *Name participating stakeholders, and describe how they are involved. Suggested word count: 50-200 words*
3.1.2 What activities are being undertaken to support local capacity building or institutionalisation? *Suggested word count: 50-200 words*
3.1.3 Are there any conflicts of interest (including the review process, if relevant)? *If so, state how these are being managed. Suggested word count: 50-200 words*

3.2 MODELLING OUTCOMES

3.2.1 Are results consistent with modelling benchmarks and other relevant comparison data? *See Section 4 for benchmarks. Please describe important deviations from these benchmarks. Suggested word count: 50-200 words*

3.2.2 If there are deviations, how should these be interpreted? *Suggested word count: 50-200 words*
3.2.3 Are other steps being taken to validate the model? *Suggested word count: 50-200 words*
3.2.4 What uncertainty and sensitivity analyses are conducted, and what conclusions are drawn from these for policy recommendations? *Suggested word count: 50-200 words*
3.2.5 Please describe the technical specifications of the economic analysis. *As is relevant, this should include:* - *The study perspective.* - *The major cost categories and program areas included/excluded from the costing, with justification if necessary.* - *Major sources of cost data.* - *The time horizon for the analysis.* - *Whether future costs and/or health benefits were discounted, and the rate used.* - *Whether economic or financial costs were estimated.* - *Whether and how economies of scale/and scope were considered.* - *The cost year and currency for results, and how inflation was dealt with.* *Suggested word count: 200-500 words*
3.2.6 Is empirical evidence available to support assumptions around the magnitude of changes in intervention coverage, quality or effectiveness, by intervention? *If yes, describe the empirical evidence. If not, has this been clearly communicated to the requesting organization? Suggested word count: 50-200 words*

3.3 MODELLING REPORT

3.3.1 Is there a more detailed model report that provides technical details of the model approach, including model structure, parameterization, cost estimates or functions, application setting and results? *If so, please provide text, a citation or link. Suggested word count: 50-1500 words*

Section 4: Benchmarks

4.1 GENERAL EPIDEMIOLOGICAL BENCHMARKS

These benchmarks describe general features of TB epidemiology, and are assumed to apply to most settings in which TB is being modelled to evaluate policy/intervention options. Unless stated, benchmarks apply to the HIV-negative population. Disease definitions (active TB, latent TB) follow standard definitions described by the WHO, as operationalised in the model. For models that provide a range of results (stochastic models, or probabilistic analyses) benchmarks should be compared to the point estimate (mean, median) reported from the model.

Benchmark name	Description	Populations / settings	Calculation	Benchmark	Value
cum_inc_adult_0-5	Cumulative incidence of active pulmonary TB over	Cohort of adults (or general pop) with no prior TB exposure, no	**$(a_0 + \ldots + a_4)/b0 * 100$** **$a_t$** = predicted new TB cases arising in year **t**	4-15%	

	the first 5 years following *M. tb* infection, no reinfection (%)	risk factors influencing TB progression risks	$\mathbf{b_t}$ = cohort size at start of year **t**		
ann_inc_adult_5p	Annual incidence of active pulmonary TB for individuals >5 years after *M. tb* infection, no reinfection (%).	Cohort of adults (or general pop) with LTBI, no risk factors influencing TB progression risks	$\mathbf{a_{t>5}/b_{t>5} * 100}$ $\mathbf{a_t}$ = predicted new TB cases arising in year **t** $\mathbf{b_t}$ = cohort size at start of year **t**	<0.2%	
tb_mort_no_tx	Case fatality (probability of death before self-cure) for active TB, in the absence of treatment	Cohort of adults (or general pop) with active TB disease, no risk factors influencing mortality risks	**a/b * 100** **a** = no. individuals dying **b** = no. individuals in an initial cohort with active disease	40-70%	
tb_dur_no_tx	**Mean** duration of active pulmonary TB in the absence of treatment (years)	Cohort of adults (or general pop) with active TB disease, no risk factors influencing mortality risks	**a/b** **a** = total life-years spent with active TB for initial cohort with active TB **b** = no. individuals in an initial cohort with active disease	1.5-4.0 years	
part_imm_prior_inf	Reduction in the risk of primary TB afforded by prior *M. tb* infection (percent)	Cohort of adults (or general pop) with prior *M. tb* infection compared to matching cohort with no prior *M. tb* infection. No risk factors influencing TB progression risks	**(1-a/b) * 100** **a** = 5-year cumulative TB incidence for cohort with prior *M. tb* infection, following new infection **b** = 5-year cumulative TB incidence for cohort with no prior *M. tb* infection, following new infection	40-85%	

Sources for general epidemiological benchmarks

1. Sloot R, Schim van der Loeff MF, Kouw PM, Borgdorff MW. Risk of tuberculosis after recent exposure. A 10-year follow-up study of contacts in Amsterdam. Am J Resp Crit Care. 2014;190(9):1044-52.
2. Trauer JM, Moyo N, Tay E-L, Dale D, Ragonnet R, McBryde ES, et al. Risk of Active Tuberculosis in the Five Years Following Infection . . . 15%? Chest. 2016;149(2):516–25.
3. Vynnycky E, Fine PE. The natural history of tuberculosis: the implications of age-dependent risks of disease and the role of reinfection. Epidemiol Infect. 1997;119(2):183-201.
4. Sutherland I. The ten-year incidence of clinical tuberculosis following "conversion" in 2550 individuals aged 14 to 19 years. TSRU Progress Report. The Hague; 1968.
5. Ferebee SH, Mount FW. Tuberculosis morbidity in a controlled trial of the prophylactic use of isoniazid among household contacts. Am Rev Respir Dis. 1962;85:490-510.
6. Tiemersma EW, van der Werf MJ, Borgdorff MW, Williams BG, Nagelkerke NJD. Natural history of tuberculosis: duration and fatality of untreated pulmonary tuberculosis in HIV negative patients: a systematic review. PLOS ONE 2011; 6(4): e17601-e
7. Andrews JR, Noubary F, Walensky RP, Cerda R, Losina E, Horsburgh CR. Risk of progression to active tuberculosis following reinfection with Mycobacterium tuberculosis. Clin Infect Dis 2012; 54(6): 784-91.
8. Brooks-Pollock E, Becerra MC, Goldstein E, Cohen T, Murray MB. Epidemiologic inference from the distribution of tuberculosis cases in households in Lima, Peru. J Infect Dis 2011; 203(11): 1582-9.
9. Sutherland I, Svandová E, Radhakrishna S. The development of clinical tuberculosis following infection with tubercle bacilli. 1. A theoretical model for the development of clinical tuberculosis following infection, linking from data on the risk of tuberculous infection and the incidence of clinic. Tubercle 1982; 63(4): 255-68.
10. Clark M, Vynnycky E. The use of maximum likelihood methods to estimate the risk of tuberculous infection and disease in a Canadian First Nations population. Int J Epidemiol 2004; 33: 477–84.

4.2 COUNTRY-SPECIFIC EPIDEMIOLOGICAL BENCHMARKS

Benchmarks describe country-specific features of TB epidemiology. Analysts can make comparison to the series of estimates most appropriate to their estimation task, possible options are shown below the table. Comparison values may be subject to estimation error, and an exact match is not required.

Benchmark name	Description	Calculation	Population / settings	Benchmark	Value	Benchmark value	Source used for benchmark

tb_incid_level	General population TB incidence rate (all forms) in the most recent available year (per 100,000)	**a_t/b_t * 100,000** **a_t** = total incident TB cases in year **t** **b_t** = total population in year **t**	General population	Use uncertainty interval provided by source of burden estimates (see below table)			
tb_incid_trend	Annual percent change in general population TB incidence rate (all forms) over the past 5 available years (%)	**$((a_t/b_t) / (a_{t-5}/b_{t-5}))^{0.2}$ *100-100** **a_t** = total incident TB cases in year **t** **b_t** = total population in year **t**	General population	Interval to be created from point estimate from source of burden estimates, +/-2 percentage points			
tb_mort_level	General population TB mortality rate (all forms, including TB-HIV) in the most recent available year (per 100,000)	**a_t/b_t * 100,000** **a_t** = total TB deaths in year **t** **b_t** = total population in year **t**	General population	Use uncertainty interval provided by source of burden estimates (see below table)			
tb_mort_trend	Change in general population TB mortality rate (all forms, including TB-HIV) over the past 5 available years (%) and annualized change (%)	**$((a_t/b_t) / (a_{t-5}/b_{t-5}))^{0.2}$ *100-100** **a_t** = total TB deaths in year **t** **b_t** = total population in year **t**	General population	Interval to be created from point estimate from source of burden estimates, +/-2 percentage points			
tb_prev_level	General population TB prevalence (per 100,000), in years for which a nationally-representative TB prevalence survey is available	**a_t/b_t * 100,000** **a_t** = total prevalent TB cases in year **t** **b_t** = total population in year **t**	General population	Only assess if recent survey conducted. Results to be compared for forms of TB assessed in survey.			
mdr_naiv_level	Prevalence of MDR-TB among treatment-naive notified TB cases, in the most recent available year (%)	**a_t/b_t * 100** **a_t** = MDR-TB cases in year **t** (tx naive) **b_t** = total TB cases in year **t** (tx naive)	Individuals with active TB, treatment naive	Where recent DRS data are available these are expected to be high quality			
mdr_expd_level	Prevalence of MDR-TB among treatment-experienced notified TB	**a_t/b_t * 100** **a_t** = MDR- TB cases in year **t** (tx exp) **b_t** = total TB cases in year **t** (tx exp)	Individuals with active TB, treatment experienced	Where recent DRS data are available these are expected to be high quality			

	cases, in the most recent available year (%)						
tb_incid_hiv	Percent of incident TB cases among HIV positive individuals, in the most recent available year (%)	**a_t/b_t * 100,000** **a_t** = incident HIV-pos TB cases in year **t** **b_t** = total incident TB cases in year **t**	General population	Only settings with HIV prevalence over 5%			
hiv_prev	HIV prevalence (%)	**a_t/b_t * 100,000** **a_t** = total HIV-pos population in year **t** **b_t** = total population in year **t**	General population	Only settings with HIV prevalence over 5%			

Options for country-specific comparison data

1. WHO TB burden estimates (http://www.who.int/tb/country/data/download/en/).
2. IHME TB burden estimates (http://ghdx.healthdata.org/gbd-results-tool).
3. Locally developed TB burden estimates.
4. Results of nationally-representative TB prevalence surveys.
5. Results of nationally-representative TB drug-resistance surveys, or high-quality drug-resistance surveillance (DRS) data.
6. In some circumstances model incidence estimates could be compared to national TB notifications data, adjusted for known differences (under-reporting, incomplete case detection, false-positive diagnosis) as relevant.

4.3 COUNTRY-SPECIFIC ECONOMIC BENCHMARKS

These benchmarks describe features of TB program resource utilization that are assumed to be country-specific. Analysts can make comparison to the data/estimates most appropriate to their estimation task, possible options are shown below the table.

Benchmark name	**Description**	**Calculation**	**Populations / settings**	**Considerations**	**Value**	**Benchmark**	**Source used for benchmark**
tb_spending	Total TB spending (inpatient and outpatient costs of TB care), including diagnostics, treatment (first line and MDR), program support and management costs) for the most recent year	**a_t** = spending in year **t** for all TB activities	Individuals receiving TB services	Benchmark applies to modelling applications designed to inform program budget estimates			
tb_cost_flt	Unit cost per person month of first line treatment	**a_t** = cost per person month for first line treatment in year **t**	Individuals receiving first line treatment	Benchmark applies if country has previously reported in GHCC or WHO World TB Report			

Options for country-specific comparison data

1. Recent program budgets or expenditure analyses (for tb_spending benchmark)
2. Unit costs estimates provided by the Global Health Costing consortium (GHCC) (https://ghcosting.org/pages/data/ucsr/app/)
3. Data/estimates available in the most recent World TB Report (http://www.who.int/tb/data/en/)

4.4 ADDITIONAL STANDARD OUTPUTS

These outputs describe features of TB epidemiology and program performance for which no benchmark is provided, but which are useful for interpreting model assumptions and results.

Output name	Description	Calculation	Populations / settings	Considerations	Value
Epidemiology					
ltbi_prev	Percentage of total population infected with latent *M.tb* infection (LTBI), in most recent year (%)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total individuals with LTBI in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	The best way to calculate these quantities will differ between models. The calculation method is provided as an example, but a different approach could be used if there is a better approach for your model.	
recent_pct	Percent of incident TB cases due to recent infection (*M.tb* infection or reinfection within the last **5** years), in most recent year (%)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** due to recent infection $\mathbf{b_t}$ = total incident TB cases in year **t**	Incident TB cases		
ari	Annual rate of *M.tb* infection for uninfected individuals, in most recent year (per 100 person-years)	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total individuals newly infected with *M.tb* in year **t** $\mathbf{b_t}$ = total uninfected pop. in year **t** (without LTBI or active TB)	Population without prior *M.tb* infection		
eff_cont_case	Average number of new *M.tb* infections / reinfections produced by an infectious case, in most recent year.	$\mathbf{a_t/b_t}$ $\mathbf{a_t}$ = total individuals infected or reinfected with *M.tb* in year **t** $\mathbf{b_t}$ = total TB incidence in year **t**	General population		
duration_tb	Duration of active TB (ie to death, self-cure, or treatment), in most recent year.	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
Care cascade [only include public sector]					
access_pct	Percent of all incident TB cases that will access TB diagnosis, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases	Leave blank If a particular transition is not modelled.	
diag_pct	Percent of all incident TB cases that will receive a positive TB diagnosis, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
notif_pct	Percent of all incident TB cases that will be notified, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
init_pct	Percent of all incident TB cases will initiate treatment, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		

complete_pct	Percent of all incident TB cases will complete a treatment regimen, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
cure_pct	Percent of all incident TB cases that will be cured via treatment, for current year	Use method most appropriate to model, to calculate population average value for all incidence TB cases	Incident TB cases		
false_pos_pct	Percent of notifications without TB (ie false positive fraction), for most recent year	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = total notifications with TB in year **t** $\mathbf{b_t}$ = total notifications in year **t**	TB notifications		
tx_private_pct	Percent of TB cases treated in private sector, for most recent year	$\mathbf{a_t/b_t * 100}$ $\mathbf{a_t}$ = TB cases initiating treatment in private sector in year **t** $\mathbf{b_t}$ = total TB cases initiating treatment in year **t**	TB cases initiated on treatment		

4.5 POLICY PROJECTIONS

These outputs describe epidemiological outcomes produced by policy projections.

Output name	**Description**	**Calculation**	**Populations / settings**	**Value**
fut_incid_trend_sq	Annual percent change in general population TB incidence rate (all forms) over the next 5 years (%), for policy scenario describing continuation of current policy and intervention coverage (ie 'status quo'), if produced	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_mort_trend_sq	Annual percent change in general population TB mortality rate (all forms) over the next 5 years (%), for policy scenario describing continuation of current policy and intervention coverage (ie 'status quo'), if produced	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_incid_trend_max	Annual percent change in general population TB incidence rate (all forms) over the next 5 years (%), for policy scenario describing maximal reduction in TB incidence, of all realistic* scenarios examined.	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total incident TB cases in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	
fut_mort_trend_max	Annual percent change in general population TB mortality rate (all forms) over the next 5 years (%), for policy scenario describing maximal reduction in TB mortality across, of all realistic* scenarios examined	$\mathbf{((a_{t+5}/b_{t+5}) / (a_t/b_t))^{0.2} * 100 - 100}$ $\mathbf{a_t}$ = total TB deaths in year **t** $\mathbf{b_t}$ = total population in year **t**	General population	

* 'Realistic' implies scenarios designed to represent policies that could feasibly be implemented based on available technology.

BRR Final Review

Section 1: Review Checklist

Based on your review of the final report, please place a cross next to each principle from the TB MAC/WHO Country-level Modelling Guidance Document to indicate whether, in your opinion, that particular aspect of the modelling application is adequate (i.e. no more than minor concerns remain) or not (major concerns remain).

Principle	**Adequate**	**Major**
Relevance: are decision-makers, policy questions, constraints, outcomes, perspectives and intervention activities clearly defined?		
Realism: are realistic assumptions made about implementation challenges and the plausibility of assumptions?		
Appropriateness: is model structure and complexity justified and appropriate to the questions and context considered?		
Evidence: is evidence appropriately gathered and checked, with expert opinion validated and uncertainty investigated?		
Validation: are model results and assumptions compared to other relevant evidence, and sensitivities tested?		
Informativeness: are a sufficient range of outputs and outcomes reported to allow for understanding of model scenarios and function?		
Transparency: are technical details clear, including model structure, implementation, scenarios, uncertainties, limitations, evidence and conflicts of interest?		
Timeliness: is the timeline/scope for modelling reasonable, or do deadlines curtail the usefulness of results in an unacceptable manner?		
Country ownership: is there appropriate engagement with and input from local stakeholders?		
Iteration: have the modelling approach, policy scenarios and results been reconsidered in light of input from stakeholders/reviewers/new data?		

Section 2: Review

Final review (reviewer): please provide your final review of the modelling application, based on the final report and related materials. *Suggested word count: 1000 words*
Final review response (modelling group): please respond to the reviewer comments above, highlighting any unresolved issues and your response to them. *Suggested word count: 1000 words*